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issues · choices · actions

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COVER: Unusual clarity of this underwater forest entices scores of human visitors into its depths. See page 8.

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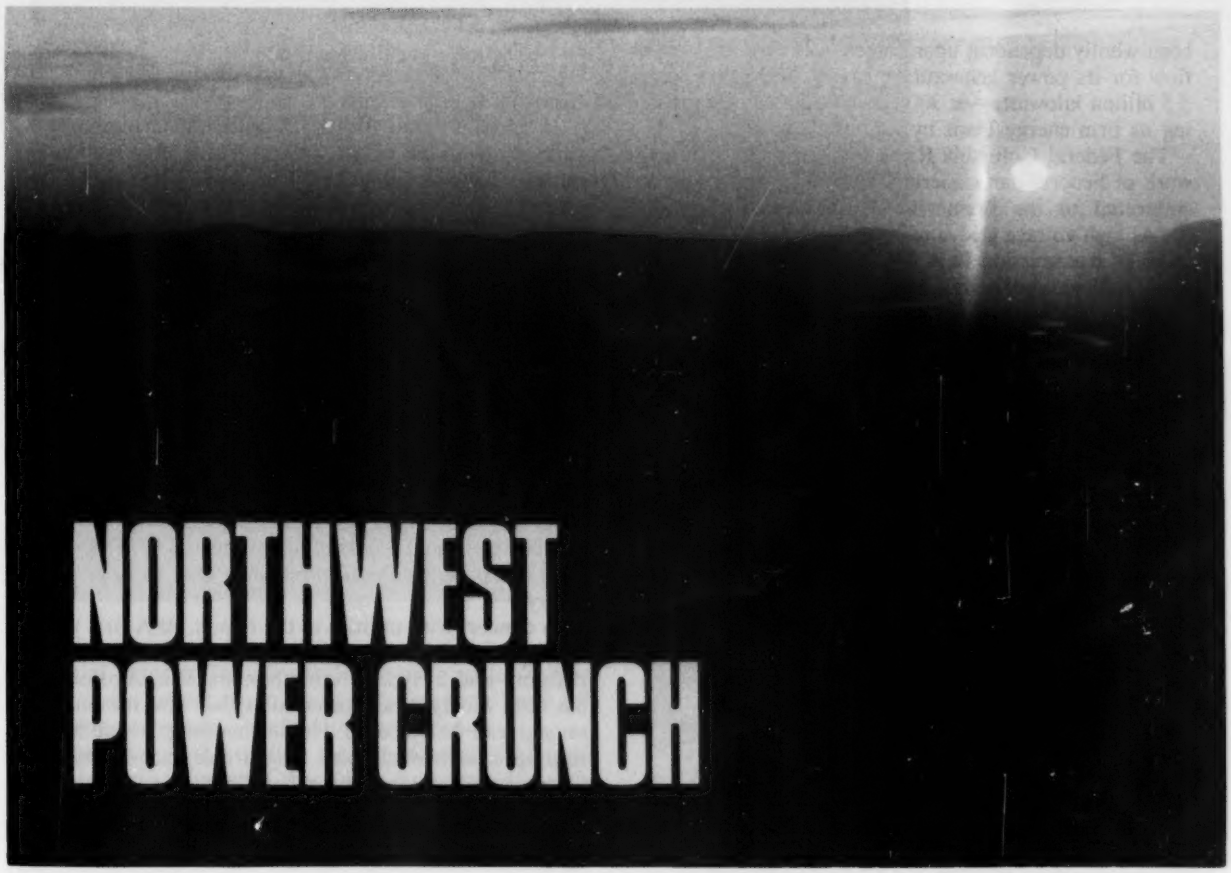


NORTHWEST POWER CRUNCH

by Don Hodel, Administrator
Bonneville Power Administration

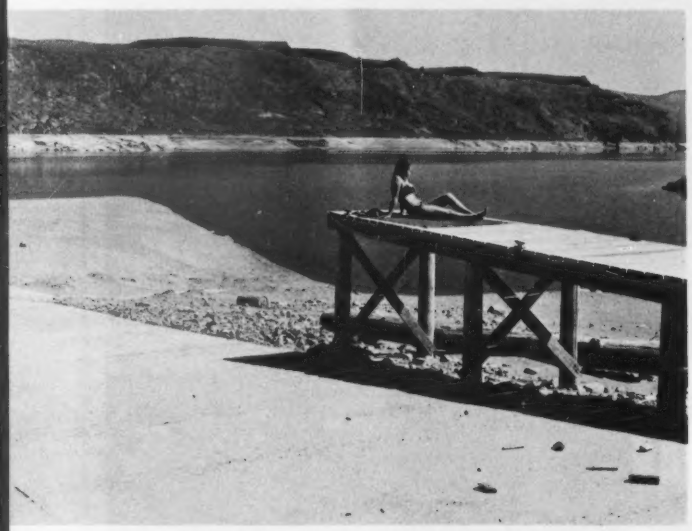
Nearly six months before the winter shortages of heating oil and gasoline brought home the full dimensions of the national energy crisis, the Columbia River Basin of the Pacific Northwest was experiencing a power-sapping water shortage. Just as motorists across the country later learned to reduce their gasoline consumption, residents of the Pacific Northwest were practicing electricity conservation on an unprecedented scale during the low-water period. Some of the voluntary curtailment appeals and techniques which made this program a regionwide success may find application in other parts of the country as they in turn face energy shortages of one form or another.

The natural blessing of the Columbia River and its tributaries plunging through steep mountain gorges has invited construction of many dams to tap this greatest of natural resources for generation of hydroelectric power. These dams, constructed by both the Bureau of Reclamation (BOR) and the U. S. Army Corps of Engineers, have provided people of the Pacific Northwest the lowest-cost electricity in the Nation because of nature's largesse. But even the mighty Columbia River, with the largest hydroelectric development of any river basin in the world, could not cope with the effects of last summer's drought. The power shortage that followed in late summer and fall was inevitable as the Columbia's watershed experienced its most disastrous drought in nearly half a century.

The region entered the spring runoff season with one of the lowest snowpack melts in history. By September it was grimly apparent that reservoir levels and stream flows throughout the region were below critical levels. Based on 95 years of record keeping, the August and September stream flows were at an all-time low. Before the heavy rains of December and January refilled them, it began to appear that all the reservoirs would be completely emptied by March 1974. Had that occurred the Federal Columbia River Power System would then have

been wholly dependent upon the run-of-the-river stream flow for its power generation, leaving the region some 3.5 billion kilowatts—or 30 percent—deficient in meeting its firm energy loads by March 1974.

The Federal Columbia River Power System is a network of Federal dams operated by the Corps and BOR connected to the Bonneville Power Administration's (BPA) high voltage grid consisting of over 12,000 circuit miles of transmission lines threading across the mountains, valleys and plains of the Pacific Northwest. It



Sun bather appropriates this dock and boat launching ramp left high and dry behind Grand Coulee Dam during last year's drought.

carries power from the hydroelectric generating plants to key population and industrial centers of the region. Part of this power is generated by private utility owned hydro projects and, in recent years, by utility owned thermal plants.

Energy Conservation Program

Based upon the grim watershed readings compiled as of July 31, 1973, (the end of the annual stream runoff period), BPA and major Northwest utilities immediately launched an intensified energy conservation program which had been in preparation for several months. Its stated objective was to provide leadership and assistance to all utilities and consumers in the region in order to effect a 7.5 percent voluntary load curtailment to counteract the energy deficit.

An announcement of this program was issued on August 9. The program includes formation of a BPA energy conservation task force that reports directly to the BPA Administrator and is headed up by the newly-created post of Assistant to the Administrator—Energy Conservation. As announced, the task force was to identify methods of saving energy and disseminating this information to the public.

In addition, each BPA field office was made responsible for working closely with its own utility and industrial customers to achieve two goals. The first was to effect internal energy economies; the second was to promote the elimination of non-essential electricity usage at the consumer level.

A series of meetings with utilities and utility associations was initiated during the month of August and met with an encouraging response. Since then, under BPA, utility, and State government leadership, energy conservation has burgeoned into a regionwide movement which encompasses all sectors of public concern. A major stimulus has been the prominence given this program by the news media, who have become staunch partners in the effort to kindle public awareness of the program, as well as reporting the steps taken by industry and business, public institutions, State and local government and private citizens in reducing their usage of electricity.

In concert with utilities in the region, BPA first identified peak and firm energy requirements by 1) consumer category and 2) type of consumption. This information has been widely disseminated to explain how meaningful savings can be achieved without imposing undue hardship upon individual users. Visual aids, fact sheets and frequent news releases have contributed to the flow of information generated by BPA and its associates in the utility industry. Speakers bureaus have been organized in numerous communities, and BPA staff from all levels of the organization have been recruited to address civic groups, schools and business associations on the need for energy conservation and how to effect it.

Close liaison has been established with State and local government, especially the public service regulatory agencies and the Governors of Oregon, Washington, Idaho and Montana—the major States affected. All of these have given strong support to the energy conservation program, and the results have been highly gratifying.

In Oregon, the 1973 Legislative Assembly passed a measure which took effect January 1, 1974. This measure requires all utilities, both public and investor-owned, to submit plans to the Public Utility Commissioner for the implementation of energy curtailment during emergencies. Meanwhile, acting on his own authority, Governor Tom McCall issued an executive order last September banning all commercial display and outdoor lighting except that deemed necessary for safety and security reasons. Subsequently, the Oregon Public Utilities Commission issued an order directing the investor-owned utilities in the State to disconnect service to customers who refused to comply with the McCall lighting ban.

Governor McCall lifted the ban on December 2, but

Northwest aluminum production is partially dependent upon "interruptible power." A closed down potline is bleak testimony to curtailment of normally surplus electric energy.

continued to ask for voluntary curtailment of commercial lighting. The commission reports up to 40 percent of the State's merchants are keeping their lights off at night in response to the Governor's plea.

The same week he lifted the ban, Governor McCall proclaimed an Energy Crisis Week in cooperation with the State superintendent of schools. Students spent their time that week discussing ways of encouraging the switching off of unnecessary lights and lowering of thermostats at home, most of which are heated by electricity in this region. Students at one high school during that week planned to concentrate on forming car pools Monday, foster patronage of energy-saving shops Tuesday, lower school thermostats to 65 degrees Wednesday, foster walking, bike riding and hitchhiking Thursday and listen to energy experts Friday.

A seventh grade class charted its school's use of fuel oil and electricity for the year in comparison to the preceding year's usage. Other schools conducted contests involving monetary prizes, posters, poetry and jingles.

Governor McCall ordered janitorial service in State buildings changed from night to daylight hours, reducing heat and light bills by some 14 percent. The State Highway Department cooperated by cutting lighting in half at some Portland area interchanges. State buildings reduced the supply of hot water available in the washrooms and turned down thermostats.

Local governments throughout the State were asked to cooperate in keeping the long-range energy conservation movement alive. Some municipal bureaus in the city of Portland cut their electricity as much as 33 percent below 1972 use. A study of over 800 city electric meters was undertaken to determine how much November's use dropped from the preceding month in an attempt to reduce municipal government usage at least 10 percent.

Industry usage continues to be a significantly crucial aspect, since the abundance of light-metal processing plants in the region draw heavily on water generated power. This prompted Governor McCall to withdraw his support for a proposed aluminum plant in the northwest corner of his State in October and, the following month, Governor Dan Evans of neighboring Washington State said the same after a meeting of the newly formed Northwest Regional Commission, which also includes the State of Idaho.

The power shortage forced Reynolds Metals Company to close down two of its aluminum potlines at Troutdale, Ore., and Longview, Wash., last summer when BPA reduced its "interruptible power" for industrial customers, laying off about 100 workers. Both lines remained closed until January. Kaiser Aluminum was forced to do the same with two potlines at its Mead, Wash., smelter.

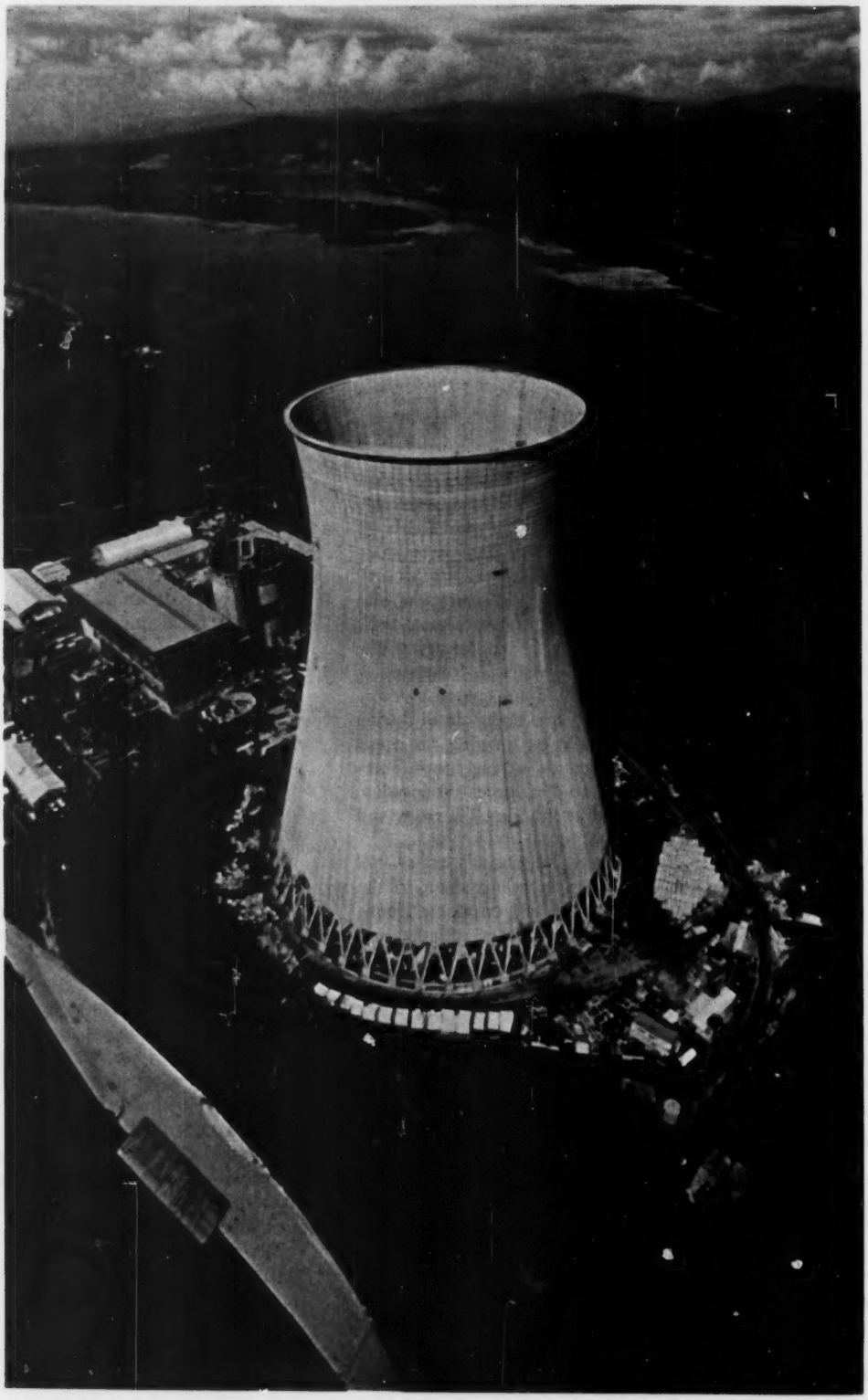
The Washington State Legislature called a special session in 1973 and enacted legislation which empowers the Governor to impose mandatory curtailment of energy usage if and when the situation demands it. Both Idaho and Montana have strongly encouraged voluntary conservation thus far, but are considering plans for mandatory curtailment.

The guidelines for such action have been generally agreed upon by the utilities in the region, acting through the Pacific Northwest Power Pool Operating Committee. Their recommendations are currently being reviewed by the governors and regulatory commissions of the four States with an eye to formulating reasonably uniform plans of curtailing electrical load on a regionwide basis if required.

The recommended curtailment plan embraces a five-step sequence based upon the severity and length of a

Even private utility owned thermal plants recently added to the regional power system marketed by the Bonneville Power Administration depend on water as a basic resource.

EPA-DOCUMERICA Gene Daniels



power shortage. These steps range from intensified appeals for voluntary conservation to consideration of so-called "rotating blackouts."

Hopefully the more stringent of the mandatory curtailment steps will never have to be taken. As of December 1973, it appeared that the short-term power crisis had been averted by the combined effect of conservation and precipitation.

Estimates compiled by the Northwest Power Pool indicate that regionwide conservation efforts yielded a 6 percent savings during the period September-November based upon forecasted loads. These efforts were complemented by heavy precipitation throughout most of the Columbia Basin during November and December. Thus, by mid-December the reservoir deficit had been reduced to 6.9 billion kilowatt-hours from the 15 billion kilowatt-hours deficit predicted in mid-August for the following 20½-month period. (The latter represents a longer term precipitation cycle.)

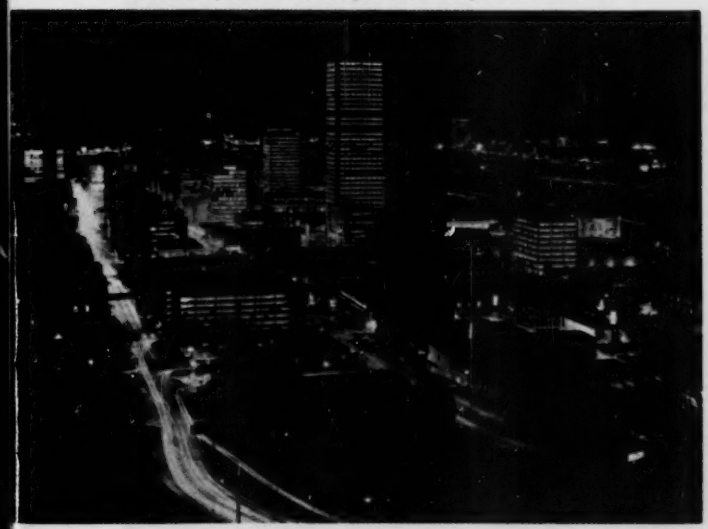
Close cooperation with Federal dam operators was a key ingredient in the region's ability to stave off its energy crisis. Originally created in 1937 as the agency for marketing power from the Bonneville Dam, BPA now markets the power generated at all of the Federal dams in the Columbia River Basin. These consist of 18 multipurpose hydro dams currently operated by the Corps, with three more under construction. Nine other hydro projects are operated by BOR, with a 10th under construction.

Recreational boaters on the Columbia River were requested to reduce their use of the locks at Bonneville,

Chief Joseph Dam is one of 18 Corps operated multipurpose projects that had to cut back on other uses to divert maximum water into generating electricity during Pacific Northwest energy crisis.

Extreme low water level of the 1973 midsummer pool behind Bonneville Dam indicates severity of short term water shortage that existed in Columbia Basin last year.

Night time Portland before and during the brownout. Photos were taken from the same spot in January 1973 and 74.

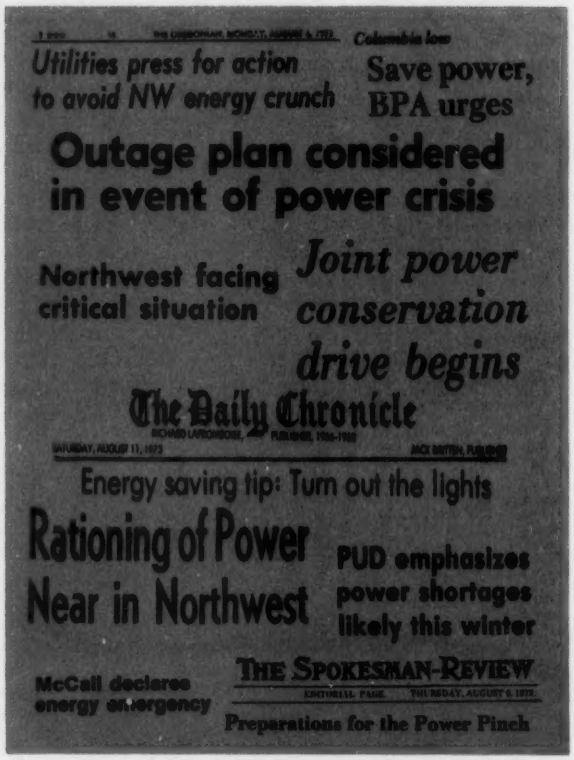


The Dalles and John Day Reservoirs by either launching their boats directly into the lake in which they planned to do the boating or ganging up with other pleasure craft and commercial vessels when locking through.

The above request was made in August by the Portland District of the Corps following the recording of 71 lockages during July to accommodate 121 pleasure craft at the Bonneville lock. These lockages used 128 million gallons, or enough to generate about 220,000 kilowatt-hours of electricity had the same water been passed through the turbines in the powerhouse section of the dam. This would have been enough energy to serve 20 homes for one year. Meanwhile, there were 72 lockages at The Dalles and 49 at John Day the same month, requiring a combined release of 703 million gallons. That amount of water would have been capable of generating 1,050,000 kilowatts—enough annual power for 117 average homes.

In an agreement with representatives of all the Northwest fisheries agencies the Corps also developed a plan to curtail fishway flows, but still permit minimal passage conditions at most dams during the months when relatively few fish were migrating upstream. The daily energy generation available from the quantity of water needed to operate the fishways at maximum level is over 1.7 million kilowatt-hours, enough to serve some 40,000 homes.

Most of this particular energy savings came from reducing the amount of water used for "attraction flow"


Columbia low

Utilities press for action to avoid NW energy crunch

Save power, BPA urges

Outage plan considered in event of power crisis

Northwest facing critical situation

Joint power conservation drive begins

The Daily Chronicle

Energy saving tip: Turn out the lights

Rationing of Power Near in Northwest

PUD emphasizes power shortages likely this winter

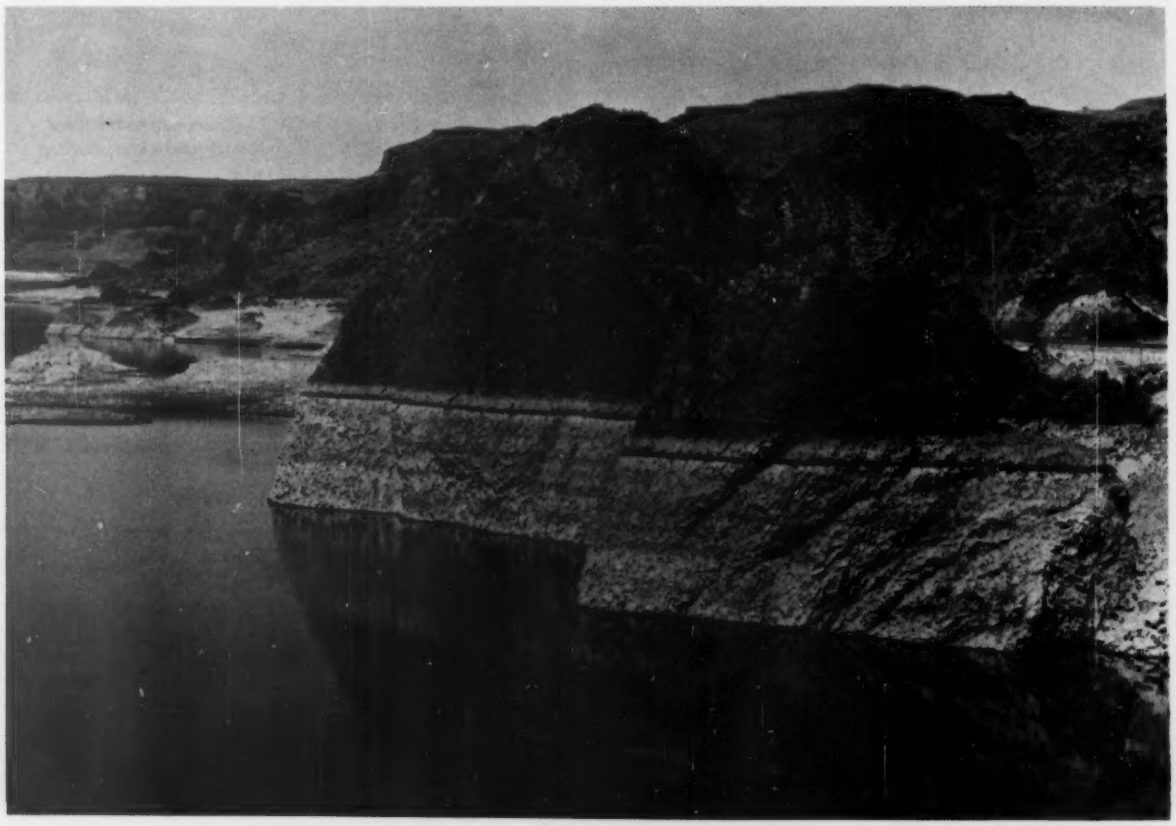
McCall declares energy emergency

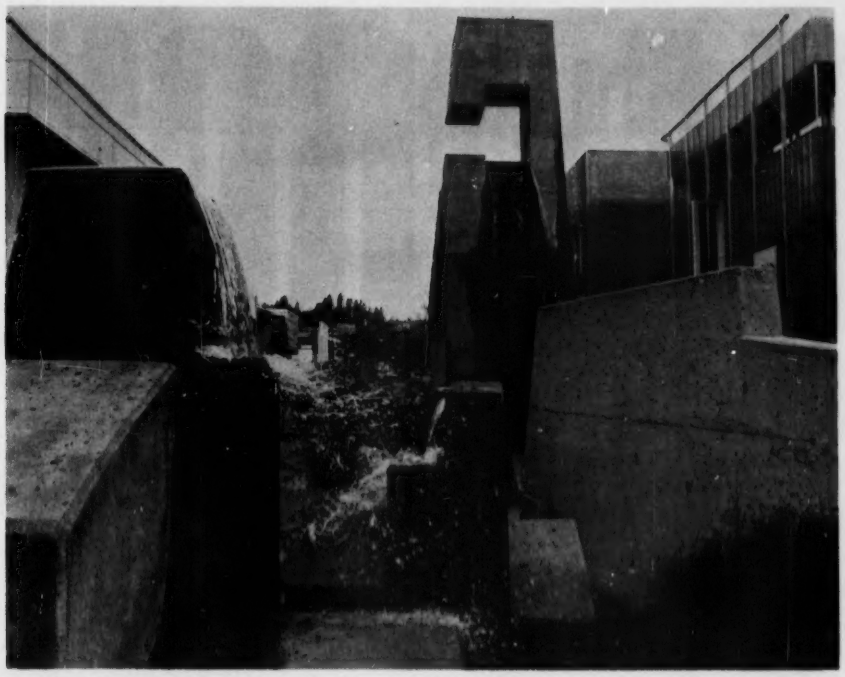
THE SPOKESMAN-REVIEW

Preparations for the Power Pinch

Newspaper headlines point up both the seriousness of the Pacific Northwest power shortage and the energy conservation program which helped alleviate it.

This lake was much lower by the time the rains came.





Along the mall in downtown Eugene the water flow ceased during the power shortage.

Photo: Glenda Powell, Eugene, Ore.

at the downstream entrances of the fishladders at Bonneville, The Dallas, John Day and McNary Dams on the lower Columbia. This represents the extra water that helps upstream migrating fish find their way into the fish passage facilities. None of last winter's fish runs were endangered by this reduction, although it was at one time feared that such a drastic action would have an adverse impact on the late fall chinook and winter run steelhead spawning above Bonneville.

Further reductions at Corps operated dams came from postponing maintenance on all of the 117 generators involved in production of electrical energy until the end of the low-water period. Rescheduling the 18-day outage needed for maintenance of Unit 5 at Bonneville, for example, saved 18 million kilowatt-hours. That was enough to supply 2,000 homes for a year. Reductions in the electricity used to light and air condition all the 18 power dams operated by the Corps during the month of August alone saved power equivalent to that required for an additional 117 homes annually.

The vast Columbia River Basin encompasses some 300,000 square miles of varied terrain populated by 6.6 million people in Washington, Oregon, Idaho, western Montana and small portions of four neighboring States. Under normal climatic conditions, this region's hydroelectric capacity enables it to export power to the Pacific Southwest grid. The situation was largely reversed during 1973, when BPA and the Northwest utilities had to purchase millions of dollars of electrical energy from California and other neighboring areas.

Another invaluable source of extra-regional energy was British Columbia, the source of the mighty Columbia River. Under the terms of a 1964 treaty with Canada for joint development of the river, the Pacific Northwest has access to water stored in three huge Canadian reservoirs for downstream power generation. The cooperation of the Canadian authorities paid off handsomely in 1973. During the period July-November. water released from the Duncan, Arrow and Mica Reservoirs generated some 6.3 billion kilowatt-hours of electrical energy—enough to meet the needs of a city of 600,000 people for one year.

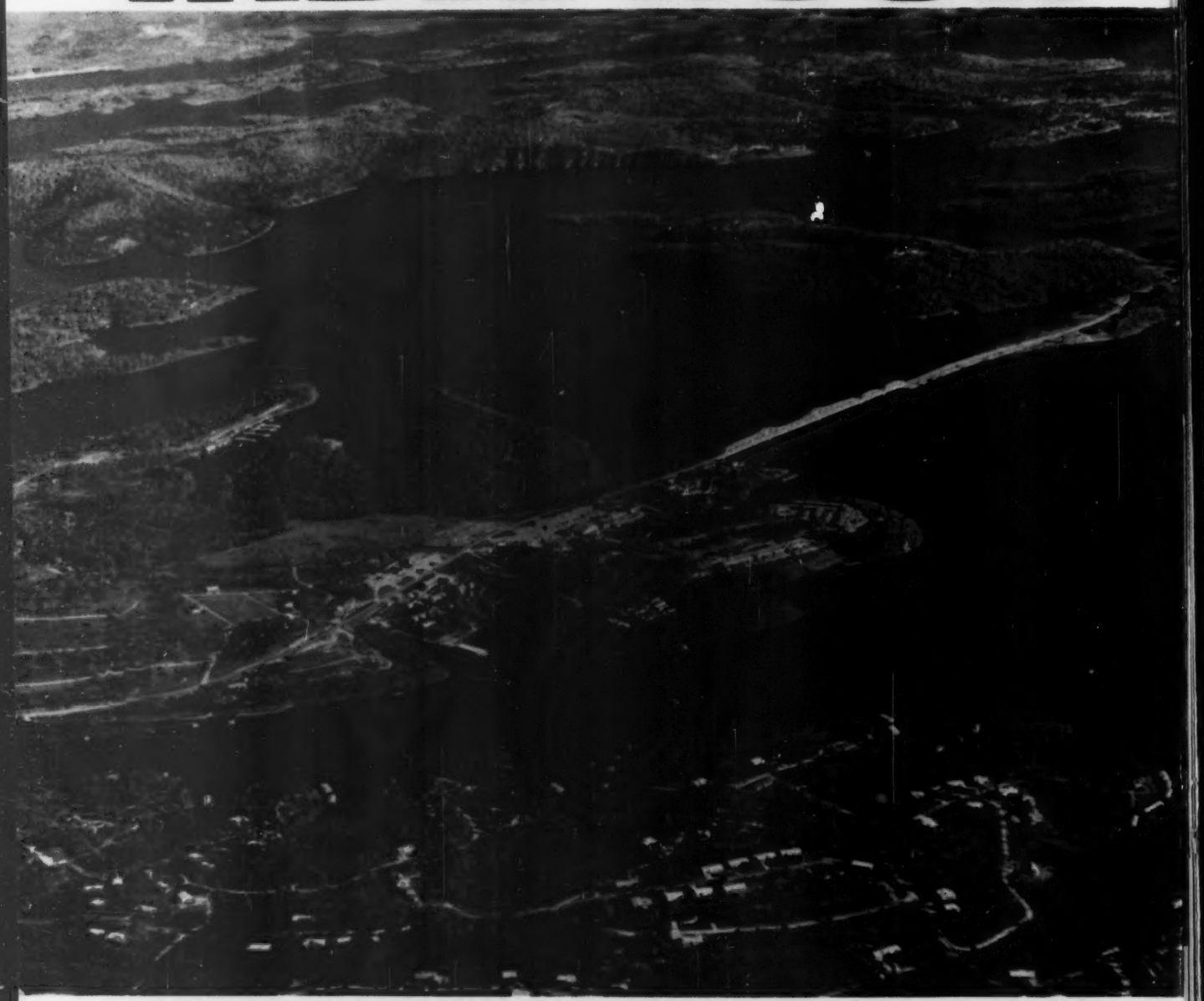
These cooperative efforts and the broad-based support for the Northwest energy conservation program averted what could have been a disastrous power shortage in the winter of 1973-74. While the immediate threat has now subsided, the region still faces a decade or more of impending shortages as its utilities endeavor to build additional generation to match forecasted load growth. The results of these efforts—including the continuing energy conservation program—should help to point the way for achieving the national goal of self-sufficiency in all energy resources.

The threat of a Pacific Northwest power shortage still exists, but here is indisputable proof that voluntary conservation can work. Given the gloomy load-resource forecasts for the coming decade, a continuing long-term conservation program may well become a way of life for those living in this region.

A growing attitude is emerging in this reference. It is still predominantly associated with those considered part of the region's counter-culture—the country people from the hinterlands, river runners, mountain craftsmen and loggers. They see their own frugal life style as the way of the future, perceiving that they have already adapted to the existing crunch.

The region has become the focus of national attention. Its critical electricity shortage in the fall, coupled to the petroleum shortage it currently shares with the Nation, makes the region's conservation measures and attitudes worthy of watching as a conservation guide. The reservoirs may be full again—perhaps overly so in view of the January floods—but the persistent feeling that the lights should stay out anyway pervades the region as an almost extrasensory awareness of energy's delicate balance.■

TABLE ROCK



Highway 13 bridge links south shore of Table Rock with Kimberling City shopping center and surrounding retirement community of Kimberling Hills.

by Seymour Reitman

Project-induced changes produce an economic boom.

Economic changes emanating from the particular project described below are by no means typical, but certainly noteworthy.

The upper White River and the Ozark Hills of southwest Missouri and northwest Arkansas have known each other for eons. The formerly free-flowing river has always provided some of the best fishing that part of the country has ever known. The eroded river-cut land—a region of cedar-covered bald knobs separated by deep-cut valleys—was much less hospitable.

Early 19th century settlers moved into the Osage tribal hunting grounds and themselves became hunters and gatherers, for the thin soil was incapable of sustained row crop production. Between the earliest written accounts of this area in 1818 by Henry Schoolcraft and the dawn of the 20th century in the Ozarks, there were no outside disturbances to change a way of life in which every family raised barely enough cotton, tobacco, tomatoes and livestock to satisfy its immediate needs.

The first break in this life style resulted from the arrival of railroads near the end of the century, but locomotives had less effect than author Harold Bell Wright, who by preserving that way of life in print helped to end it in reality. Publication of his novel *Shepherd of the Hills* in 1907 focused national curiosity on the Matthews family homestead at Inspiration Point, several miles west of Branson, Missouri, that Wright had used as his novel's setting. Wright's book sold 17 million copies in the first few years after publication.

The unwanted notoriety brought as many as 50 sightseers a day to the Matthews farm where "Old Matt" ground corn for the local community. Continuing streams of tourists watching him at work and peering in his window even as he ate finally annoyed "Old Matt" to the point where he hitched up the family wagon and drove off in the dark of night four years later. However, by 1911 one could already hear the sounds of construction in the distance—around Forsyth—where the Empire District Electric Company out of Joplin was using mule and horsepower to build the first dam on the upper White River, which rises in the Boston Mountains of Arkansas to the south. Completion of Powersite Dam in 1913 formed a 20-mile long, 100-200 yard widening of the river. This new lake was named Taneycomo, a contraction of its geographical location—Taney Co., Mo.

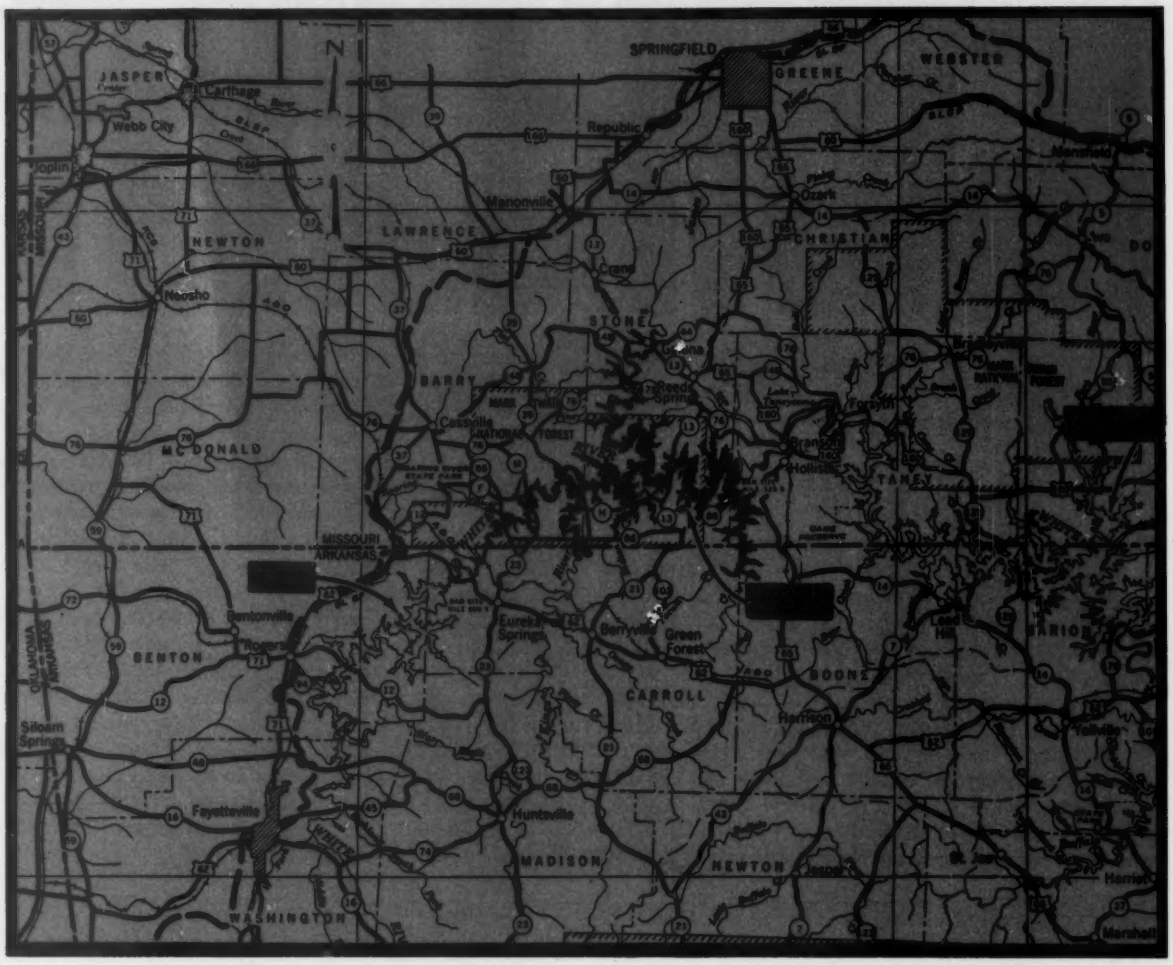
Although built to provide Empire District with a source of hydroelectric power, the manmade creation of a flat water area in this mountainous region provided the first obvious recreation center for southwest Missouri. The new lake soon spawned popular resort areas along its shores. Rockaway Beach, nestled next to Forsyth, rapidly gained national fame for the Ozarks. Many of the Nation's more affluent spent their summer vacations in shoreside cabins and hotels in the area around Hollister, Branson and Forsyth. The Missouri Pacific brought them as far as Branson, across the lake from Hollister. Float fishing in Ozark "johnboats" became famous on the upper White under the guided tours of men like Jim Owen of Branson—who always instructed his guides to talk authentic hillbilly for the wealthy guest fishermen the area attracted.

After World War I, Taneycomo began to attract a wider variety of recreation enthusiasts, encouraging the growth of hotels, bungalows, bait and tackle shops, boat rentals and repairs, amusement parks and other visitor oriented activities. After all, in 1920 the Empire District's dam and lake was still considered the biggest in this part of the country.

Onset of the Depression brought an economic decline lasting through the 30s as dollars became scarce and regional transportation patterns changed.

Meanwhile, congressional attention began to focus on the upper reaches of the White River as a combined source of hydroelectric power and potential location for flood control structures. The river's importance lay in the geographic fact that it rises in the foothills of the Ozark Mountains of northwest Arkansas and flows northward in a sweeping arc through southern Missouri's Ozarks before dipping southeastward into Arkansas again on its way to the flat, almost swampy flood plain of the lower Mississippi River. The total system of both flood control and generation of hydroelectric power authorized by the Flood Control Act of 1941 was envisioned as a creation of four lakes linked in tandem on the upper White: Beaver, Table Rock, privately owned

Table Rock's fingers of water spread among five Missouri-Arkansas counties.



Taneycomo and Bull Shoals. Amendments to the Flood Control Act of 1944 provided for the addition of recreational facilities at all future projects.

Thus, when construction of Table Rock Dam by the Corps of Engineers began in 1952 it had multiple purposes to serve, including coordination of fish and wildlife management with other Federal and State agencies. Table Rock was completed seven years later in May 1959, forming a lake that extends 79 miles upstream into the tailwaters of Beaver Dam above it. Built only six miles above Branson, Table Rock's own tailwaters spilled directly into Lake Taneycomo below. The new high rise Table Rock Dam perched above it drastically changed the environment of Taneycomo. The latter's 1,730 acres of water surface seemed instantly tiny compared to Table Rock's 43,100 acres at conservation pool level, which created an extensive 745-mile long shoreline that had never before existed. At flood control pool height, the lake surface expands to an even larger 52,300 acres with an 857-mile shoreline.

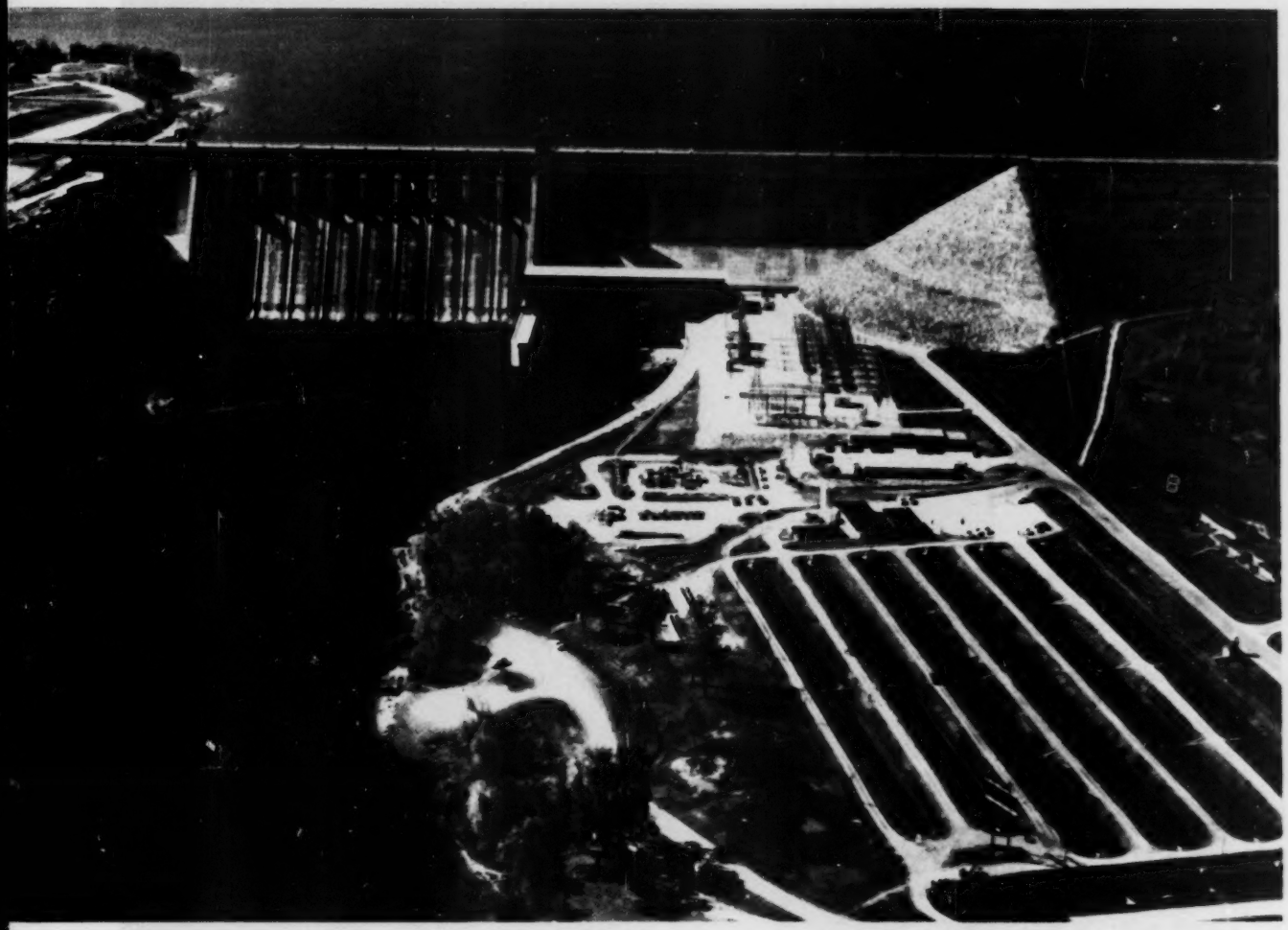
Table Rock's sheer size would have drawn off a goodly portion of the smaller Taneycomo's visitors, but in a more gradual time scheme, had not a curious transformation of Taneycomo's waters taken place.

Although Federal and State fishery experts had long warned local residents to expect cooling of the lower lake's water, the latter were still unprepared for the abruptness of the change and the sharp drop in water temperature caused by drawing the chilling, 140-foot deep Table Rock water through the dam's turbine penstocks into Taneycomo.

With boating, waterskiing, swimming and warm water fishing quickly abandoned on Taneycomo, the Missouri Department of Conservation built Shepherd of the Hills Hatchery immediately below Table Rock Dam on Corps leased land. Its purpose was to establish a replacement fishery of rainbow trout that have successfully thrived in the artificially cold waters.

In recent years, however, the State has become aware that the low level of dissolved oxygen in the cold water

Shepherd of the Hills Hatchery, right foreground, breeds the rainbow trout that thrive in the cold water drawn past Table Rock Dam's turbines into Lake Taneycomo.



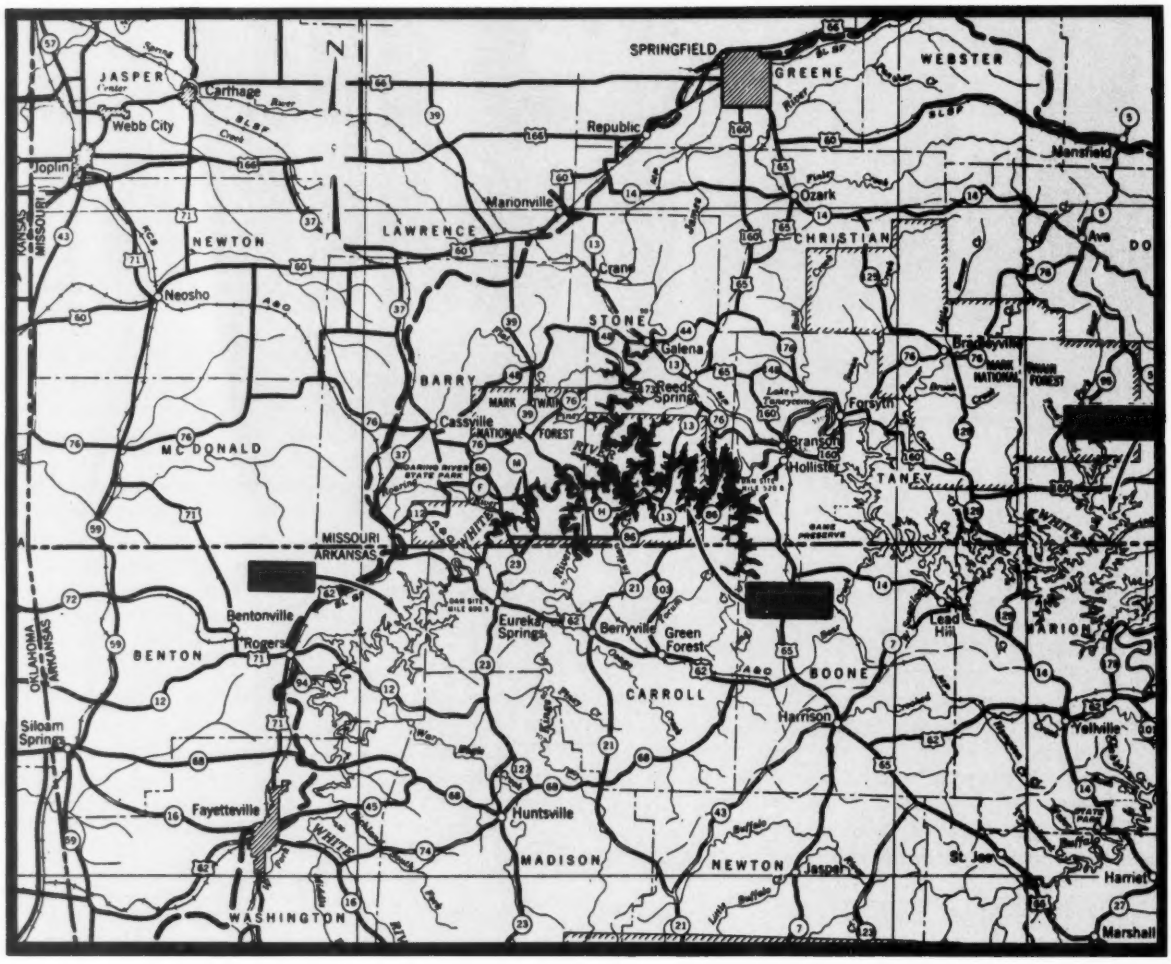
flowing from Table Rock affects the health of the trout in Taneycomo. In response to requests by the State, the Corps has tried several methods of injecting gaseous oxygen directly into the lake water under pressure. Ready for next season is a new liquid oxygen tank constructed near Table Rock Dam by resident engineer Richard B. Groves. The next time the dissolved oxygen level drops below acceptable minimums during summer periods of low flow, the Corps will start to draw this stored oxygen through hoses leading to the turbine shafting in the penstocks, where oxygen gas will be injected into the water immediately prior to entering Taneycomo.

The fortuitous circumstances that brought side-by-side warm and cold water fishing to Table Rock and Taneycomo, respectively, have made the area around Branson and Hollister a year-round mecca for fishermen from near and far. Vast numbers of fishing camps, bait and tackle shops, marine sales and service and small grocery stores dot the shorelines and access road system.

Between fishing season peaks come the summer vacationists who not only enjoy Table Rock and Taneycomo but also their surrounding parks and tourist attractions. About 75 percent of the area is located within the bordering Mark Twain National Forest. The Missouri State Park Board has established Table Rock State Park on 457 acres leased from the Corps near the damsite at the lake's eastern end, not far from the mountain peak which shared its name with the manmade lake. The Corps itself, in addition, operates over 20 small park sites offering various degrees of amenities for day picnickers and overnight campers, all of which are supervised by a staff of park managers and rangers operating out of the resident engineer's office near Branson.

These parklands are located in an extremely narrow belt of Corps owned real estate in which the Corps staff also manages woodland areas containing wildlife habitats. Complicating its management preferences are

Table Rock's fingers of water spread among five Missouri-Arkansas counties.



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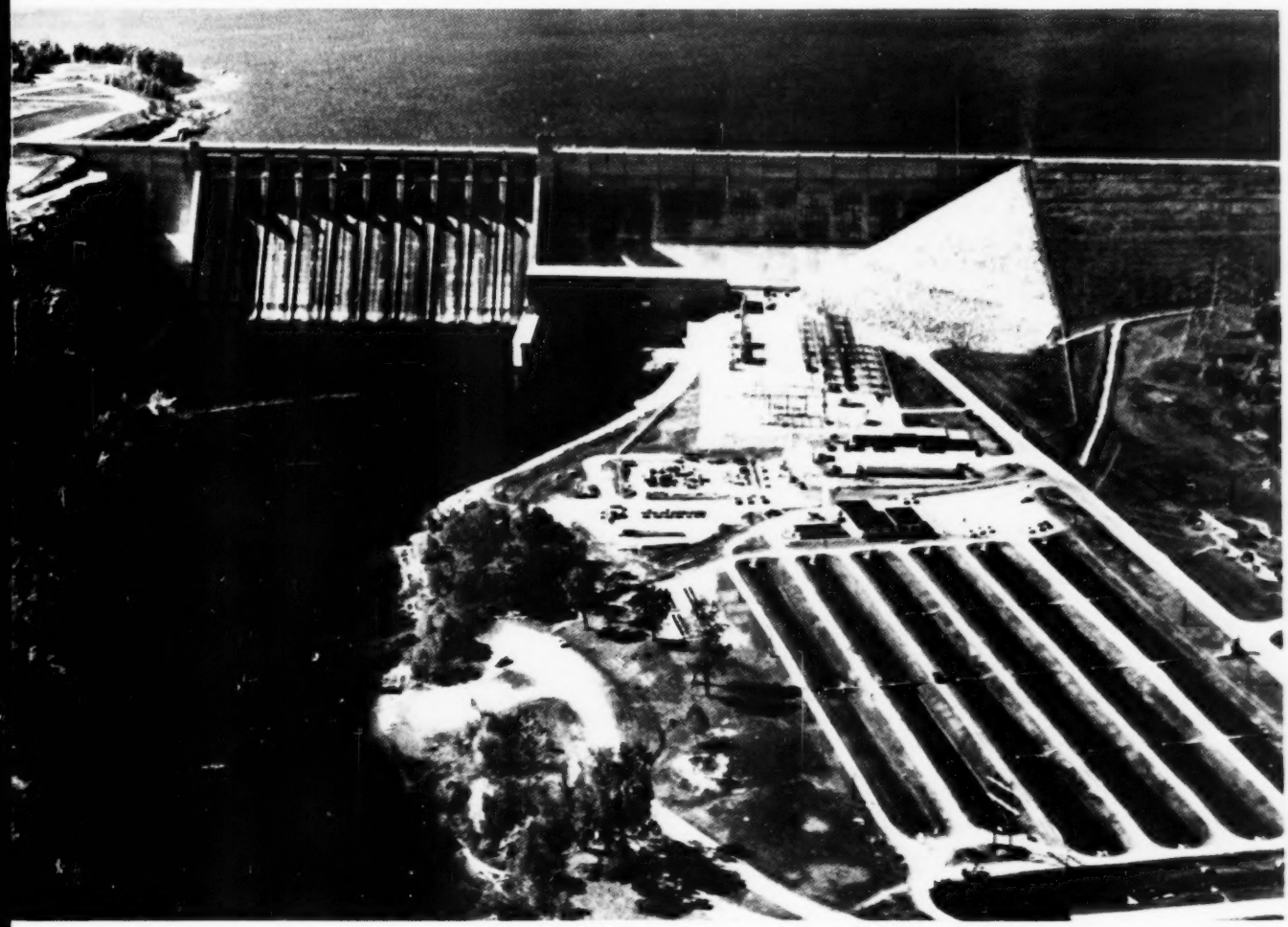
In recent years, however, the State has become aware that the low level of dissolved oxygen in the cold water

Shepherd of the Hills Hatchery, right foreground, breeds the rainbow trout that thrive in the cold water drawn past Table Rock Dam's turbines into Lake Taneycomo.



flowing from Table Rock affects the health of the trout in Taneycomo. In response to requests by the State, the Corps has tried several methods of injecting gaseous oxygen directly into the lake water under pressure. Ready for next season is a new liquid oxygen tank constructed near Table Rock Dam by resident engineer Richard B. Groves. The next time the dissolved oxygen level drops below acceptable minimums during summer periods of low flow, the Corps will start to draw this stored oxygen through hoses leading to the turbine shafting in the penstocks, where oxygen gas will be injected into the water immediately prior to entering Taneycomo.

The fortuitous circumstances that brought side-by-side warm and cold water fishing to Table Rock and Taneycomo, respectively, have made the area around Branson and Hollister a year-round mecca for fishermen from near and far. Vast numbers of fishing camps, bait and tackle shops, marine sales and service and small grocery stores dot the shorelines and access road system.

Between fishing season peaks come the summer vacationists who not only enjoy Table Rock and Taneycomo but also their surrounding parks and tourist attractions. About 75 percent of the area is located within the bordering Mark Twain National Forest. The Missouri State Park Board has established Table Rock State Park on 457 acres leased from the Corps near the damsite at the lake's eastern end, not far from the mountain peak which shared its name with the manmade lake. The Corps itself, in addition, operates over 20 small park sites offering various degrees of amenities for day picnickers and overnight campers, all of which are supervised by a staff of park managers and rangers operating out of the resident engineer's office near Branson.

These parklands are located in an extremely narrow belt of Corps owned real estate in which the Corps staff also manages woodland areas containing wildlife habitats. Complicating its management preferences are

Photo: Robert H. French of John The Diver, Inc.

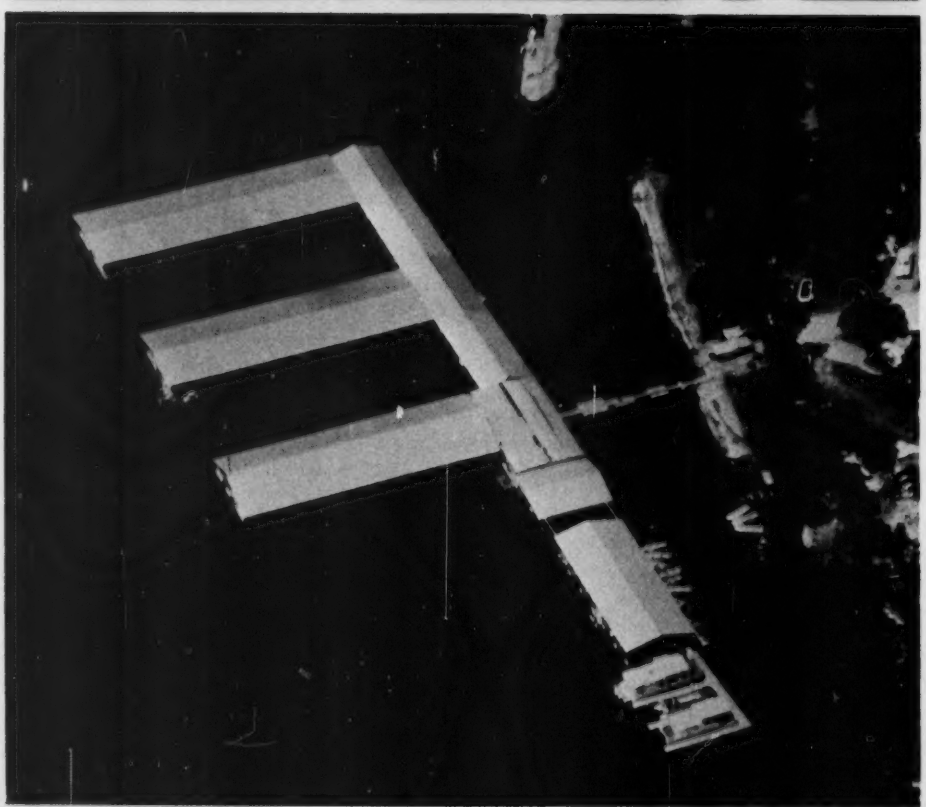


Photo by Associated Graphics, Inc., Kimberling City

Opposite- Crayfish beckons scuba enthusiasts to explore underwater sights in the Ozarks.

Bottom left- Table Rock's resident engineer attempts to limit docking patterns to those that please the eye and will not offend the environment.

the large numbers of private landowners and developers next door to the Corps, so to speak, who derive certain benefits from the lake's proximity to their property. Some have been bold enough to request removal of intervening woodland obscuring a "vista" view of the lake from their home sites. The resident engineer's staff usually reminds such requesters that boaters on the lake might not appreciate a scenic lakeside vista marred by private cottages.

From the air a multitude of watery fingers appear to inundate the narrow hollows of yesteryear, to form little creeks, forks and branches of such appealing nature that 278 subdivision sites have sprung up around them. There is no part of the lake near which a subdivision does not exist. Among the largest is the incorporated community of Kimberling Hills with over a thousand permanent inhabitants and its own sizeable shopping center—Kimberling City. The majority of these subdivisions eventually become year round retirement settlements. Some young family purchasers even buy early in their working careers, then rent their homes until they reach retirement age—knowing a place is waiting for them at Table Rock under this gradual retirement plan.

The last four to five years have also seen tiny unincorporated towns such as Shell Knob sprout from a wide spot in the road with the customary grocery store and gas pumps to its own 20-store shopping center. Real estate values around this part of the lake ran about $60 to the linear foot in 1968, had spurted up to approximately $450 a foot between 1970 and 1971—and are still booming.

This attraction for proximity to Table Rock transcends the normal magnetism of large bodies of water. In resident engineer Groves' assessment, the clarity of the water is the most unique aspect of Table Rock among its neighbors. Even 120 feet down scuba divers discover such clear water that surface ripples are still visible. A variety of fish and underwater phenomena may be studied and photographed with ease in this underwater world frequented by professional and amateur alike. John "The Diver" Hoynacki, a local professional, is continually amazed at the new discoveries awaiting each of his descents.

Table Rock's clarity can be attributed to the insignificant amounts of clay and silt type soils atop the nearly horizontal layers of limestone through which runoff filters before the White River tributaries drain into the lake. Thus, the very soil conditions that prevented profitable farming in earlier years now insures Table Rock's clarity for posterity.

The clearness of its water and the backdrop of its forested hills make Table Rock perhaps too attractive for its own good. In 1973 the resident engineer's office issued 120 limited lease permits to boat dock owners scattered along the shoreline. Such permits restrict use of the dock facilities to an owner's bonafide motel guests if his property is adjacent to Corps land. Groves could have allowed more docks, but he contends that Table Rock should remain "first cabin" and the "hub" of the action in this region for visitors from as far as New Orleans to the south, St. Paul to the north, Denver to the west and Ohio to the east.

Thus, he maintains a standing policy that shoreline separation among a limited number of lakeshore docks prevents visual pollution and permits enough open space for continued public access to the lake. The need for retaining public access is important, Groves pointed out, when one considers that 40 percent of Table Rock's visitors come from outside Missouri and neighboring Arkansas. The heaviest out-of-state impacts noted by his rangers are from Iowa, Illinois, Kansas and Texas.

The Corps is also responsible for controlling Taneycomo's pollution and navigation. Up to 1969 only a letter of permit was required for a private boat dock. Now each request has to be examined to determine the explicit location of the proposed dock and then coordinated with the Missouri Conservation Commission and the lake owners, Empire District Electric Company. The 120 limited leases are issued among the 330 motels situated around the Table Rock shoreline. Beaver Lake by comparison, has only five motels with lakeside access but more retirement type communities with year round accommodations and state highway frontage. Table Rock

Lake Taneycomo begins in the tail waters of Table Rock Dam.

Bottom right-Table Rock sparkles amidst its frame of colorful plumage, providing an aesthetic experience for fishermen and pleasure boaters.

leases include 13 commercial concessionaires catering to the boating public where out-of-state people berth their boats year round.

Recently Groves has been advocating turning all of the Table Rock and Taneycomo docks perpendicular to the shore in order to use even less shoreline than is necessary with parallel docking patterns. "I hope to see us go to the multilift storage concept," Groves declared, in an effort to conserve shoreline. However, he admits, environmentalists may not agree that high-rise boat docks are compatible with the scenic shoreline. Groves also encourages community docks such as the "courtesy dock" provided by Holiday Isle subdivision for its lot and home owners.

The Corps concern is based on its Table Rock records, which show an approximately 1000 percent growth in the number of privately owned boats permanently kept on the lake from 765 in 1960, two years after the dam's completion, to 7,242 in 1972, the latest year for which figures are available. Rental boats maintained by both concessionaires and resorts in the same period climbed from 842 to 1,336.

The growth in boat usage is attributable to the growth around the lake. In 1960 over 2.4 million persons visited Table Rock. By 1972 that number increased almost threefold to over 6.3 million. Not all were overnight guests, since there were only 41 establishments providing 1,353 such accommodations when the lake first opened in 1958. By 1972 there were 281 establishments capable of accommodating 10,104 visitors overnight. The estimated value of these establishments rose from $1.5 to almost $16 million in the intervening years.

Besides these commercial establishments, private home and recreational site construction adjacent to the lake represented over $92 million of investment value in 1972. Another $3.6 million worth of non-resort type businesses have also been constructed in the vicinity of the lake.

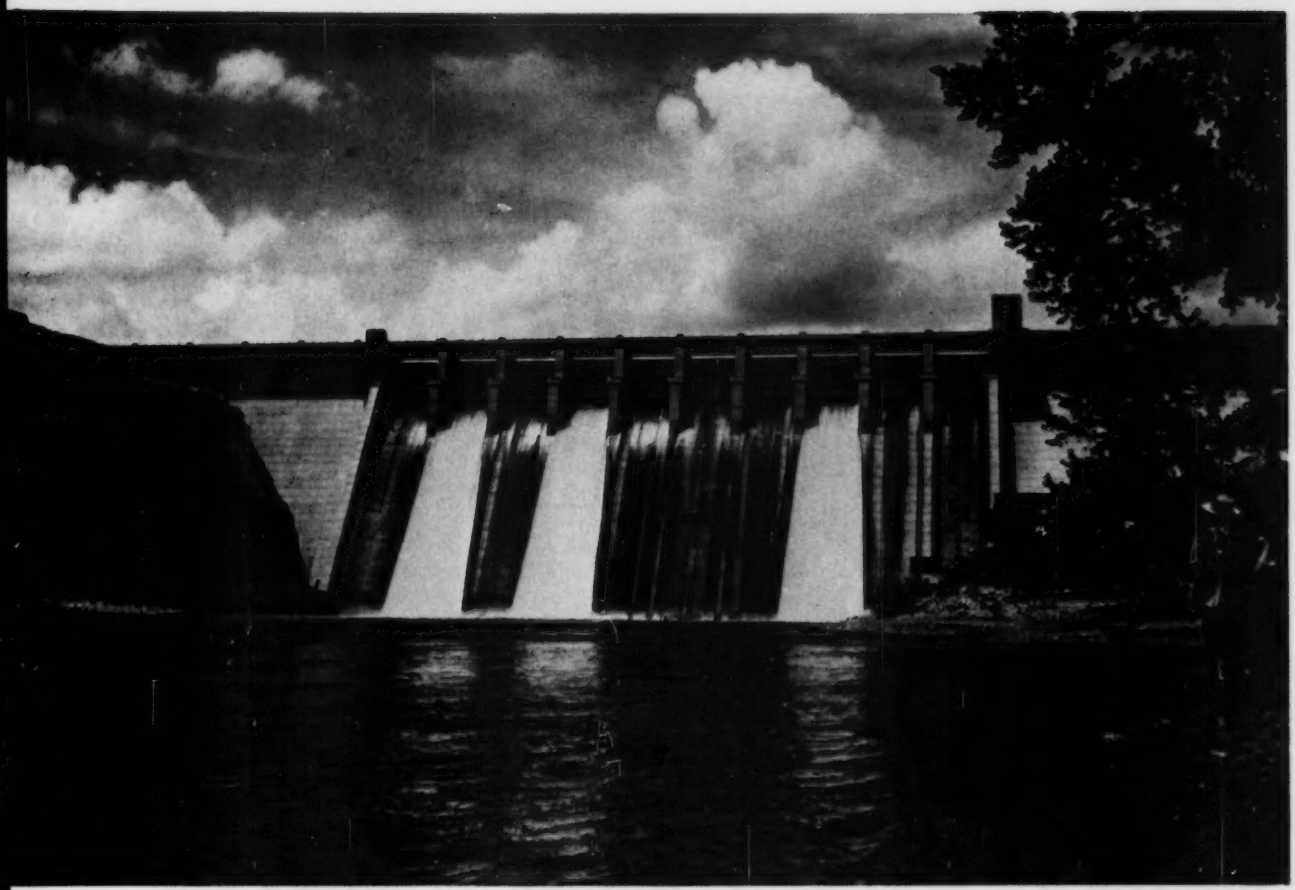
The rise in motel population has been accompanied by continuing growth in the fishing industry supported by the lake. Almost $6 million worth of fishing tackle, bait, boats, motors and other outdoor recreation equipment is sold annually in the lake's vicinity. The $2 million of commercial boating facilities is dwarfed by the $17 million value placed on privately owned boating equipment used on the lake. What percentage is purchased outside the immediate vicinity of the lake has not been recorded, but the growth since 1958 in marine sales distributorships as far away as Springfield is visibly evident to permanent residents of the area.

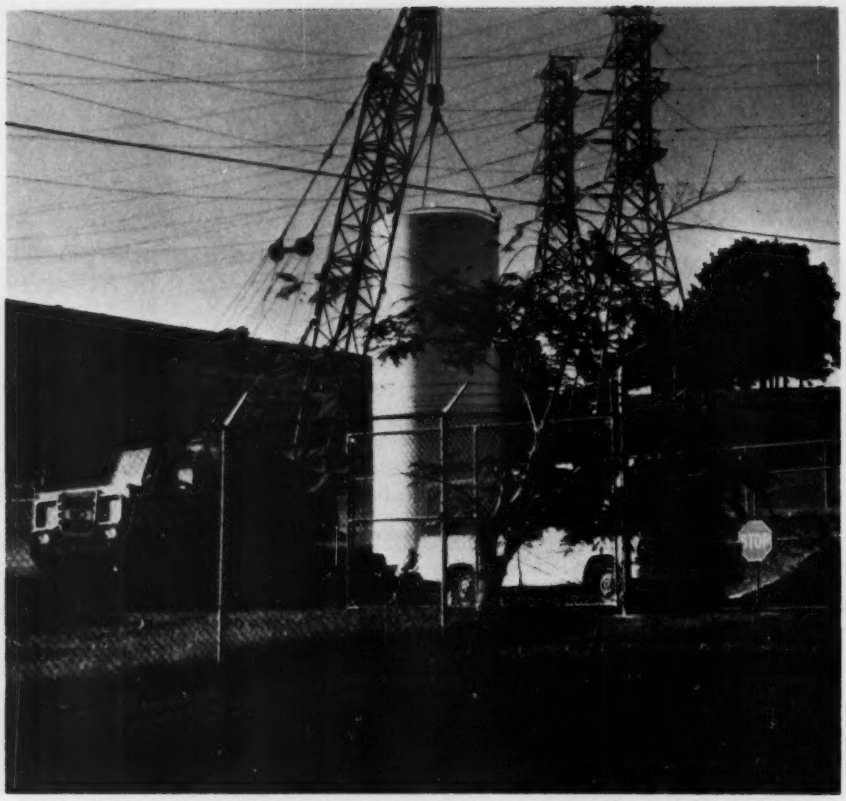
Since the lake sprawls its fingerlike projections over a five county area along both sides of the State line, a look at county assessment values represents a more overall view of true growth within the area. The combined assessed valuation of all taxable property in these five—Taney, Stone and Barry in Missouri, Carroll and Boone in northern Arkansas—was slightly over $55 million when Table Rock was completed. Today that figure is well over $121 million.

Banking institutions and their deposits also grew with the coming of Table Rock. Back in 1950, according to Ben Parnell, Jr., president of the Peoples Bank and Trust Co. in Branson, the Security Bank was the only one in Taney County, and had less than $2.5 million in total assets. That was before start of construction on Table Rock. Today, Parnell's own bank and the Bank of Taney County, organized at Forsyth in 1958, also exist. Furthermore, all three county banks have total assets somewhere between $60-65 million. In neighboring Stone County, there was only one bank in 1950, located in Crane, with assets of approximately $2 million. There are now two other Stone County banks in Reeds Spring and Kimberling Hills. All three show combined assets running $20-25 million. Today there are also three savings and loan institutions in Branson alone, all relatively recent additions to the community, and one of them a branch of an established savings and loan headquartered in Springfield.

Before Table Rock, outlying ranches sold for $10 an acre and an average Branson city lot went for $500-$1,500. Today the asking price for ranches is between $500 to $1,000 an acre and city property averages anywhere from $4,000 to $15,000 a lot. Owners of Branson lakefront lots along the Taneycomo shoreline who bought at $1,000 refuse offers of $15,000 today.

Among the communities adjacent to the White River and its manmade lakes, Branson stands out as the gateway for southwestern Missouri's resort region due to its transportation facilities. The Missouri Pacific first opened up the region by bringing the railroad to Branson in 1907. This made it possible for outsiders to visit the

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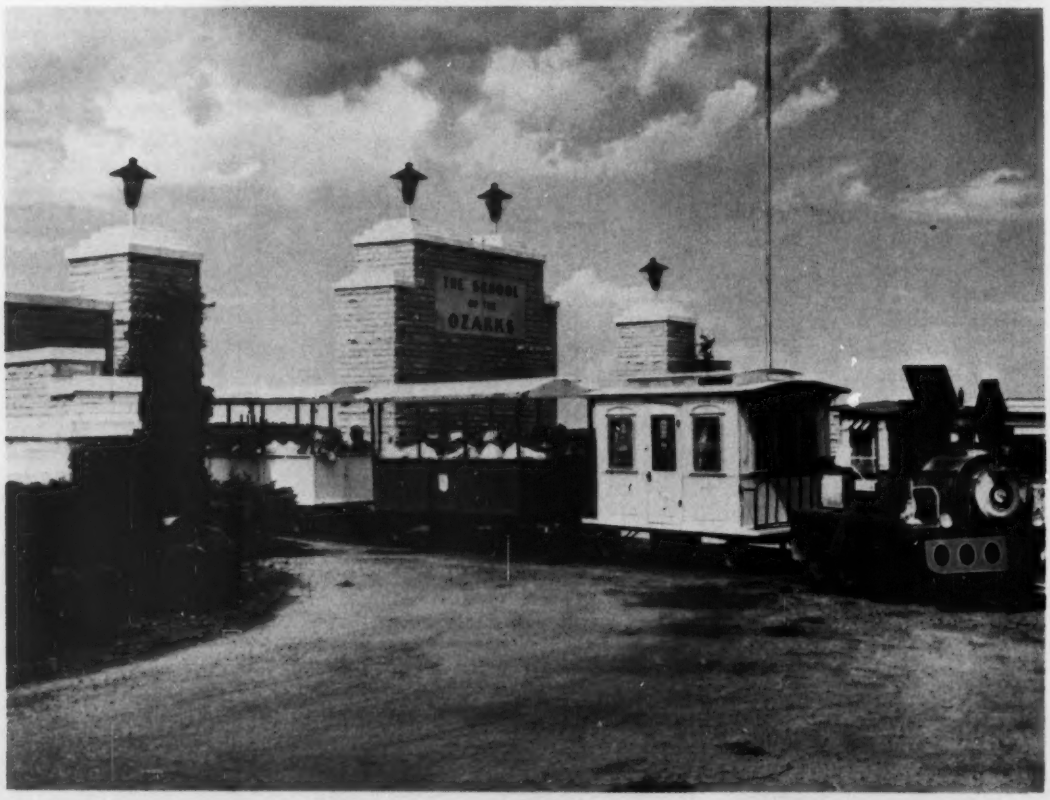

THE SCHOOL
OF THE
OZARKS

Opposite-Contents of this liquid oxygen tank will be pumped into water drawn through turbine penstocks of Table Rock Dam whenever low levels of dissolved oxygen threaten the downstream rainbow trout fishery.

Bottom left-"S of O Special"—a former Lake Placid ski train with wheels—starts tour of student operated campus industries at School of the Ozarks.

Shepherd of the Hills site and the underground wonders of nearby Marvel Cave. Then Highway 65 from Springfield, the line to the outside world of Kansas City and St. Louis, became progressively important with the gradual decline of rail passenger service.

Today this "straight as a string," partially four-laned, modern highway is only 38 miles between Branson and the 100,000-population city of Springfield. Quick and comfortable, it slices through enormous cuts and glides over monstrous-sized fills. Vacationers heading for Table Rock can even bypass Springfield today. Construction of a Branson bypass began last year and should be available for summer 1974 tourists not wanting to contribute to downtown Branson congestion where U. S. Highway 65 intersects with State Highway 76 heading west toward Table Rock.

Upon completion of the bypass, Taney County will start on a public access road to the nearby airfield near Hollister on the School of the Ozarks campus. Though open to general aviation use, the school airfield has only been accessible to the public by driving through the campus.

Though started with the idea of becoming the area's public airport, it was built by student labor and has been serving as an on-campus aviation science and flight training site for its own students in addition to providing public charter and flight rental service.

This unusual school was founded in 1906 by Rev. James Forsythe, a young Presbyterian missionary, to educate the mountain children at a time when there were few schools in the Ozarks. From a boarding grade school it evolved into a high school, then a junior college and finally, in 1964, became a full four-year nondenominational, coeducation college of liberal arts. Each change in curricula came in response to the slow increase of better public schools in the Ozarks and a gradual realization that a progressively higher level of education was needed as the region developed.

The scenic campus at Point Lookout, only two miles east of Branson, contributes to the overall tourism appeal of the Table Rock-Taneycomo area. Heading west on Highway 76 out of Branson today's visitor meets a partial resurrection of the former 160-acre Matthews homestead at Shepherd of the Hills Farm. An outdoor theater, claiming the second largest attendance in the country, adjoins the old mill where summer tourists witness nightly reenactments of Ozark family life during "Old Matt's" days.

Closer to Table Rock, on the opposite side of 76 is Silver Dollar City, sharing its site with Marvel Cave, whose 20-story high interior is said to be the third largest cave in the Nation. Silver Dollar City presents 19th Century craftsmen and actors working in a replica of an 1880 pioneer mining town that includes an old "tintype" photo studio as well as a retelling of the exploits of former Ozark vigilantes known as the "Bald Knobbers."

A helicopter ride provides aerial views of Table Rock, excursion boats offer lake tours, barns with distinctive hillbilly names offer country music and the local roads are lined with a ceaseless variety of small museums, zoos, restaurants, motels and shopping centers.

There is no doubt that Table Rock has been a boon to the Ozarks together with its sister lakes on the upper White River. As 1974 marches forward into the beginnings of another tourist season, the energy crunch will certainly rear its head in the Tri-Lakes area of Table Rock, Taneycomo and Bull Shoals. An early January article in the *Branson Beacon* reported a telephone survey of resort owners pointing to a consensus that more tourists would come for full vacations from shorter distances, but that the number of one- and two-day trips would decline.

Since then the winter snow and ice have disappeared, the dogwood, redbud and shadbush blooms have dropped, and the moment of truth is arriving for 1974. End of the year visitation tallies will help determine the direction of regional economic decisions for the near future. For the long range future of the Ozarks the very permanence of Corps lakes such as Table Rock serves as a manmade anchor among the economic waves of uncertainty. Table Rock's magnetism is not likely to diminish in its power to attract visitors to southwest Missouri.■

HIGH-RATE LAND TREATMENT

by **Herman Bouwer,** Ph.D

The "no-discharge" policy contained in the Federal Water Pollution Control Act Amendments of 1972 is creating an unprecedented interest in land treatment of liquid wastes—especially those of organic origin. The nature of this interest is twofold: Land treatment not only keeps wastewater out of streams or lakes, it also recycles "pollutants" in the water for immediate reuse in fertilization of crops and eventual reuse of the water.

Where water is plentiful, the main objective of land treatment is to keep the wastewater out of streams and lakes, even though irrigation benefits may be obtained as an added bonus. Where water is short, the irrigation use or renovation for other uses may be the main objectives. Other appealing aspects of land treatment systems are their simplicity, reliability, and low energy requirements in contrast to the complex technology and high energy requirements of advanced-treatment sewage plants.

When conventionally treated (secondary) sewage effluent or similar wastewater moves through soil to become renovated water, there is generally complete removal of suspended solids, biodegradable organic material (as expressed by the biochemical oxygen demand or BOD), and fecal coliform bacteria. In addition, constituents such as phosphates, metals, and fluorides are greatly reduced. Purification through land treatment also takes advantage of the fact that disease causing microorganisms have a limited travel capability in most deep agricultural soils. Although these purification processes occur mostly in the first few feet of soil, the water should be allowed to travel at least several hundred feet before it leaves the groundwater basin,[1] both as a safety precaution and for additional *polishing treatment.* The water can leave the underground naturally, via springs or drainage into streams or lakes, or artificially by manmade wells or drains.

[1]This distance is not very well defined. It depends on the soils and on the use of the renovated water. Sometimes 20 feet may be sufficient. *Several hundred feet* merely denotes the general order of magnitude necessary to be on the safe side.

Application of wastewater to land areas may be considered under two categories: low rate per acre and high rate per acre. Each has advantages under different conditions.

A primary consideration is the efficiency of nitrogen removal by each system. For drinking water use, the U. S. Public Health Service limits nitrogen contents to no more than 10 milligrams per liter of nitrate-nitrogen; and wastewater ready for application to land may contain 20 to 40 milligrams, mostly in ammonium form. Under aerobic soil conditions, nitrogen is converted to the nitrate form by means of nitrification. This point, then, affects the respective benefits that differentiate low from high-rate systems of effluent applications.

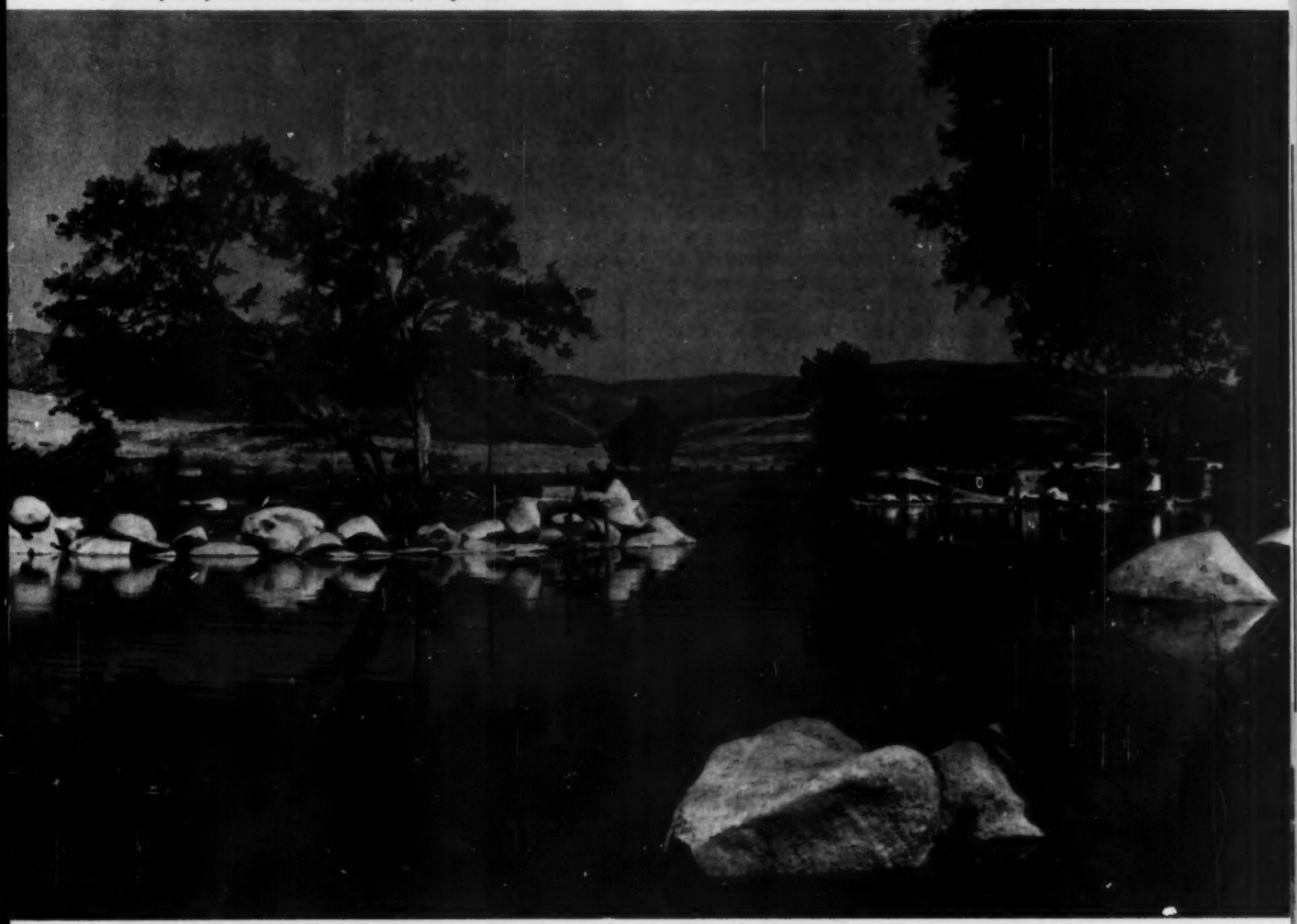
Low-Rate Systems

Secondary sewage effluent contains 50 to 100 pounds of nitrogen per acre-foot. If this effluent is applied to land at the low rate of 1 inch per week, about 2 feet of effluent are applied in a 6-month period, which is the growing season in most temperate climates. This means that some 100 to 200 pounds of nitrogen are applied per acre. Since the average uptake of nitrogen by crops ranges from about 60 pounds per acre for wheat to as much as 600 pounds per acre for frequently mowed grass, it is not surprising that crops will remove most of the nitrogen in the wastewater, leaving renovated water with low nitrogen concentrations. Also, at these low rates, the amount of renovated water moving down through the soil will be rather small and dilution by rainfall may be a significant factor in helping to reduce these concentrations. Under these circumstances the low rate system is satisfactory.

However, if sewage effluent is used for irrigation in arid regions, approximately 3 to 4 feet of effluent may be applied per year or growing season. With this amount, which is still a relatively low rate, more nitrogen may enter the soil with the effluent than the crops can take

Dr. Bouwer is Director of the U.S. Water Conservation Laboratory, Agricultural Research Service, USDA, Phoenix, Ariz.

Recreational lake filled with renovated sewage effluent from rapid infiltration basins at Santee, California.



up. The result may be that the nitrogen converted into nitrate moves down to well below the root zone together with the excess irrigation water applied to keep salts leached out of the root zone. The salt concentration in this so called deep-percolation water is several times that of the irrigation water or effluent. Since this deep-percolation water eventually reaches the underlying groundwater, salt and nitrogen concentrations in the groundwater below sewage-irrigated fields eventually may exceed those of the original effluent.

Buildups of salt can only be removed in arid regions by the standard agricultural practice of draining them into a waste ditch or salt lake. Excessive nitrogen buildups, however, require promotion of denitrification in the soil by increasing the amount of wastewater to a high-rate level of application. Therefore, low-rate systems appear best suited to humid areas with sufficient rainfall to dilute these concentrations.

A disadvantage of applying wastewater at low rates is that large land areas are required. At 1 inch per week application, for example, a city of 100,000 people would need some 3,000 acres to dispose of its sewage effluent on land (assuming year round application). Where this poses a problem, the land area can be reduced by applying the effluent at higher rates.

High-Rate Systems

The systems classified as high rate will accommodate several feet per acre per week, depending on the permeability of the soil.

Sandy loams or loamy sands are the most suitable soils for these "high-rate" systems because they are permeable enough to permit high infiltration rates and fine enough to provide sufficient purification of the wastewater as it seeps downward. High original water tables are not objectionable if the water table can be controlled at the proper level by installing artificial drainage systems. The wastewater may be applied to the land through use of sprinklers, furrows, or basins, depending upon the topography.

Periods of infiltration should be rotated with periods of resting or drying the soil. This permits the infiltration rates, which usually decrease during application, to recover. Drying periods are also necessary to bring oxygen into the soil for oxidation of ammonium and organic matter by bacteria. The optimum combination of infiltration and drying periods depends on the type soil, the wastewater constituents, and the climate—a combination that can best be evaluated by local experimentation.

The Flushing Meadows Project in the Salt River bed near Phoenix, Arizona, is an example of a high-rate basin infiltration system. Maximum long-term infiltration of secondary sewage effluent was obtained with flooding periods of 18 days alternated with drying periods of 10 days in summer and 20 days in winter. With this schedule as much as 400 feet of effluent entered the soil in 1 year (flooding the basins to a depth of 1 foot). This is about one-fourth the saturated hydraulic conductivity of the soil, which is a fine, loamy sand. At this hydraulic loading rate, about 30 acres of basin area are required to infiltrate the effluent of a city of 100,000 people—much less than the 3,000 acres required for the low-rate system.

Another advantage of high-rate systems is that the salt content of the renovated water is about the same as that of the wastewater. As mentioned before, this is of particular importance in arid regions, where low-rate systems could yield renovated water with much higher salt concentrations than the original wastewater.

Since the amount of plant nutrients applied to the soil is much greater than crop uptake with high-rate systems, extra care is necessary to minimize the impact on the underlying groundwater. Thus, each high-rate system should be managed to (1) produce renovated water of as good a quality as possible, particularly with respect to nitrogen and phosphorus, (2) restrict the spread of renovated water in the groundwater basin, or (3) both.

Maximizing Nitrogen Removal

About the only way to remove significant amounts of nitrogen in high-rate systems is by stimulating denitrification in the soil. This is a biological process whereby denitrifying bacteria use the oxygen of the nitrate in their digestion of organic matter, thereby forming free nitrogen gas that returns to the atmosphere. This process requires the presence of nitrate and organic carbon (as "food" for the denitrifying bacteria) under anaerobic conditions.

Some dentrification occurs "naturally" even in normally farmed soils. As a rule of thumb, for example, about 50 percent of the nitrogen applied as crop fertilizer is not utilized by the crop and denitrification accounts for about one-half of this nitrogen loss. With excessive nitrogen applications, however, the naturally occurring denitrification process will be insufficient to remove significant amounts. Thus, the land treatment system should be managed to stimulate dentrification, which can be done by bringing nitrates and organic carbon together under anaerobic conditions.

If sewage effluent is applied to soil in small, frequent amounts, the soil is mainly aerobic and most of the ammonium in the effluent (which is the predominant nitrogen form) will be converted to nitrate with little or no denitrification. At the Flushing Meadows Project, this occurs when basins are flooded 2 days and dried 5 days. However, if longer flooding periods are used (10 days flooding and 14 days drying, for example), oxygen becomes depleted in the soil during flooding and ammonium is no longer converted to nitrate. This ammonium is then adsorbed by the clay and organic matter in the soil, and, consequently, ammonium and nitrate concentrations in the renovated water are both low. The total nitrogen content of the renovated water at this stage is often 60 to 90 percent less than that of the sewage effluent.

As flooding is continued, the clay and organic matter eventually become saturated with adsorbed ammonium, and ammonium appears in the renovated water. Flooding should be stopped before this happens, so that the soil dries and atmospheric oxygen can enter the soil. This will result in bacterial oxidation of the adsorbed ammonium to nitrate (nitrification), freeing the clay and organic matter adsorption sites for future storage of ammonium during subsequent floodings.

The nitrate that is not denitrified during drying is leached out when flooding is resumed. This nitrate causes a temporary nitrate "peak" in the renovated water below the basins. As the flooding cycle continues, oxygen again disappears in the soil, resulting in renewed adsorption of ammonium, etc.

Overall nitrogen removal via this pattern of long flooding and drying is estimated at about 30 percent. This includes the nitrate that is leached out at the start of a new flooding period and causes nitrate peaks in the renovated water. Since the total nitrogen entering the soil with the effluent amounts to about 24,000 pounds per acre per year, the soil system removes approximately 7,200 pounds per acre per year through denitrification.

This is much more than the few hundred pounds or so that a crop can take up. However, crops may have a stimulating effect on denitrification because their roots give off organic carbon and take up oxygen. Evidence of this has been obtained in field and laboratory studies, but more research is needed before crops and crop management can be used as tools in obtaining more denitrification in high-rate land treatment systems.

The 70 percent of the nitrogen that is not removed from the wastewater when using 10-day flooding periods is concentrated in a relatively small volume of the renovated water. This is the newly infiltrated water carrying leached out pockets of nitrate that formed during the drying periods. Laboratory studies on soil columns show that if this nitrate-rich portion of the renovated water is collected and put back in the infiltration basins—where it could mix with the sewage effluent and again infiltrate the soil—the overall nitrogen removal could be increased to about 75 to 80 percent.[2]

[2] J. C. Lance and F. D. Whisler; *Nitrogen Removal During Land Filtration of Sewage Water.* Proceedings, International Conference on Land for Waste Management, Ottawa, Ontario, Canada, 1-3 October 1973.

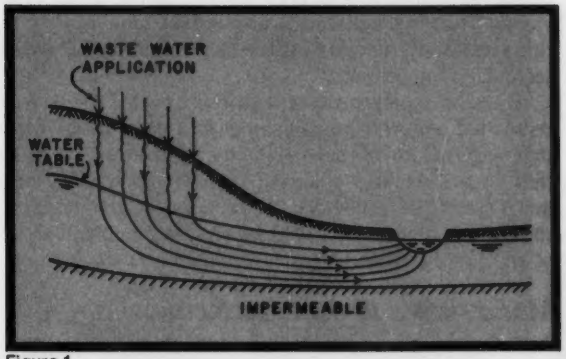


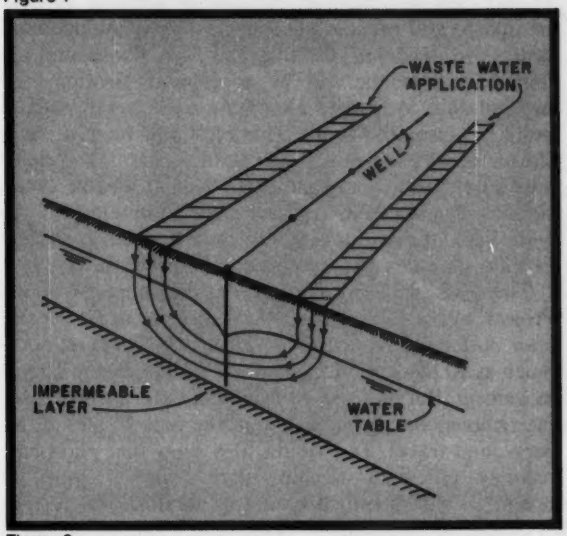
Figure 1

Figure 1. Renovated wastewater draining naturally to stream or lake.

Figure 2. Pumping renovated water from wells midway between infiltration strips. This system can be operated so that no native groundwater enters the wells.

Figure 3. Pumping renovated water from wells (black dots) on both sides of a long infiltration strip or around a circular infiltration area. Both systems pump mixture of renovated water and native groundwater.

Figure 4. Top drawing shows removal of renovated water from shallow aquifers with subsurface drains. Lower two show continuous system of infiltration strips utilizing alternate wetting and drying. Drain beneath each infiltration strip is closed during its wastewater application period to avoid short underground travel.



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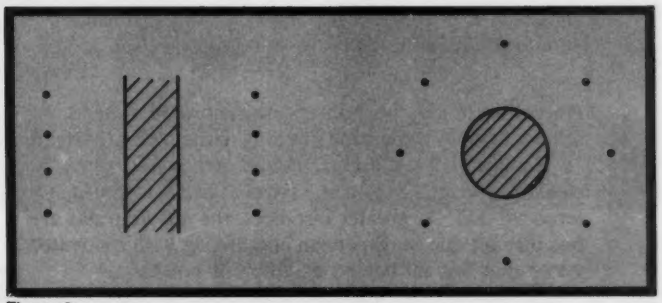

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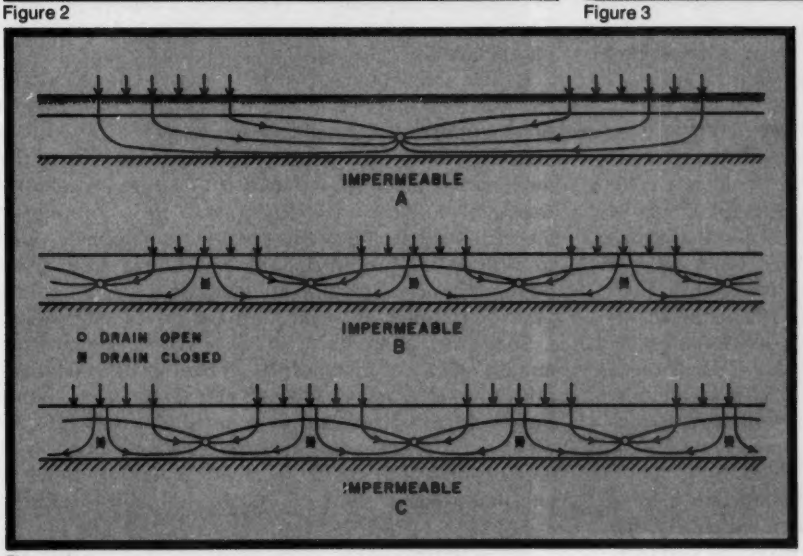

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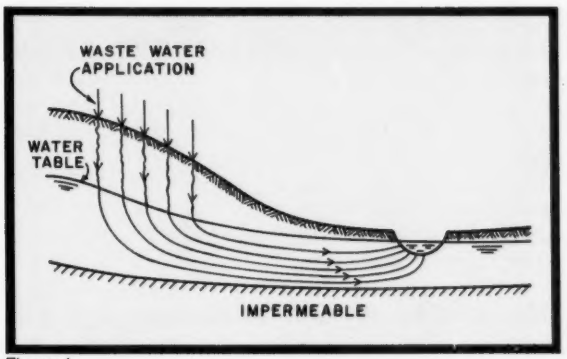

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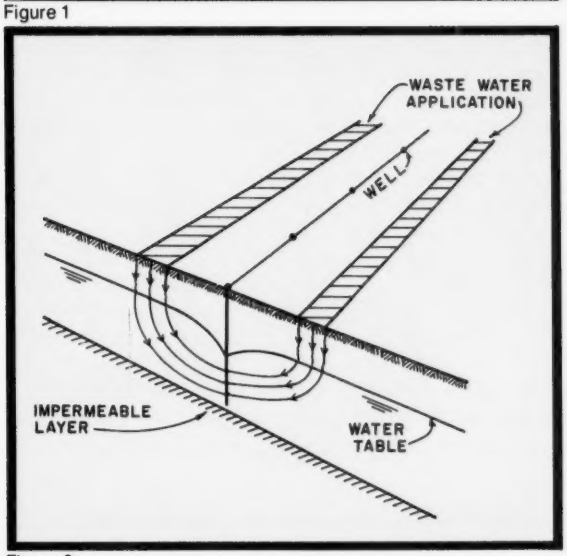


Figure 2

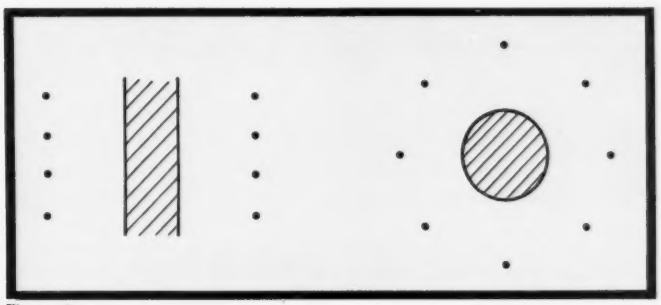


Figure 3

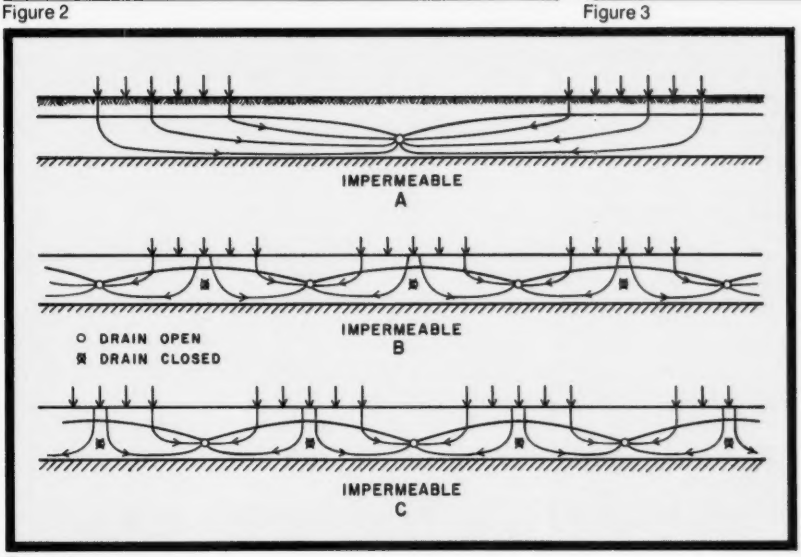


Figure 4

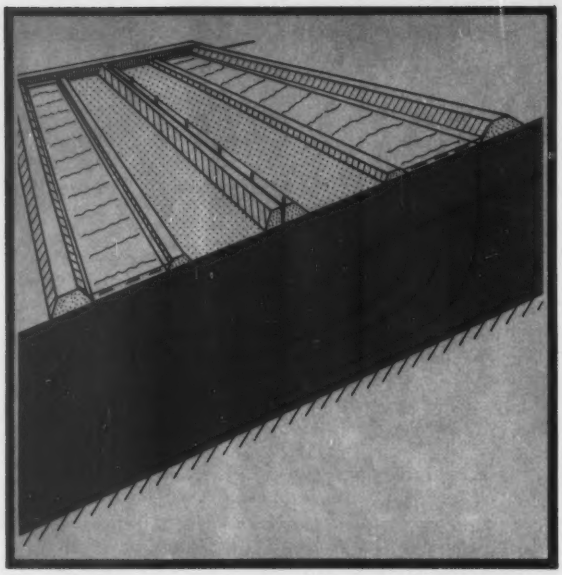


Figure 5. Cross section of proposed 40-acre infiltration system in which effluent entering from intermittently flooded basins becomes renovated water pumped from wells in center dike for unrestricted irrigation use.

Recycling of this portion of the renovated water containing most of the nitrate could be done with tile drains or shallow wells that can collect renovated water at relatively short horizontal distances from where it entered the soil. At greater distances, the nitrate peaks are less distinct due to dispersion and mixing with renovated water that has infiltrated at different points.

The laboratory studies conducted by Lance and Whisler also show that decreasing the infiltration rate by reducing the water depth is also effective in promoting denitrification. This is because lower infiltration rates will give better mixing of the nitrate formed during drying with the newly infiltrating sewage effluent each time flooding is resumed. Also, lower infiltration rates will cause this nitrate to move slower and, hence, to remain longer in the upper portion of the soil where the organic carbon and microbiological processes are concentrated. Better mixing and longer times in the biologically active zone both increase the opportunities for denitrification. Nitrogen removal was found to increase exponentially with decreasing infiltration rate. For example, reducing the infiltration rate from 1 foot/day to 0.5 foot/day increased total nitrogen removal from 30 to 80 percent in the laboratory soil columns, according to Lance and Whisler.

The above techniques should be field-tested before they can be applied in practice. This is currently being done at the Flushing Meadows Project. Generally, the management of a high-rate system to maximize denitrification may not be the best for producing good crop yields. Thus, agricultural utilization of land in a high-rate system may not be possible or it may be relegated to secondary importance.

Also, the management of high-rate systems to produce renovated water of maximum quality may differ from that required to obtain maximum infiltration rates. In that case there is a trade-off between the quality and quantity of the renovated water. How a given system should be managed will then depend on the intended use of the renovated water.

Maximizing Phosphate Removal

Another key element in wastewater renovation is phosphorus, which occurs in the sewage effluent as both phosphate and organic phosphorus in a combined concentration of about 10 milligrams/liter. Phosphates are immobilized in the soil by adsorption, fixation, and precipitation. Adsorbed phosphate may slowly be converted to insoluble forms. Thus, soil may be capable of storing more phosphorus over the long term than quick adsorption tests would indicate. Even in coarse sands, significant phosphate removal can be obtained if the wastewater is alkaline and sufficient calcium is present to form complex calcium phosphate precipitates.

This was demonstrated at the Flushing Meadows Project, where phosphate removal was about 50 percent after 30 feet of vertical underground movement and as much as 90 percent after an additional 100 feet of lateral movement. But increasing the application rate decreased the removal rate, particularly in the first 30 feet of underground travel. Test results also show that phosphate removal efficiency remains stable after 5 years of operation, during which a total of about 43,000 pounds of phosphate-phosphorus (PO^4-P) were applied per acre. Thus, the soil has a tremendous capacity to fix and store phosphates.

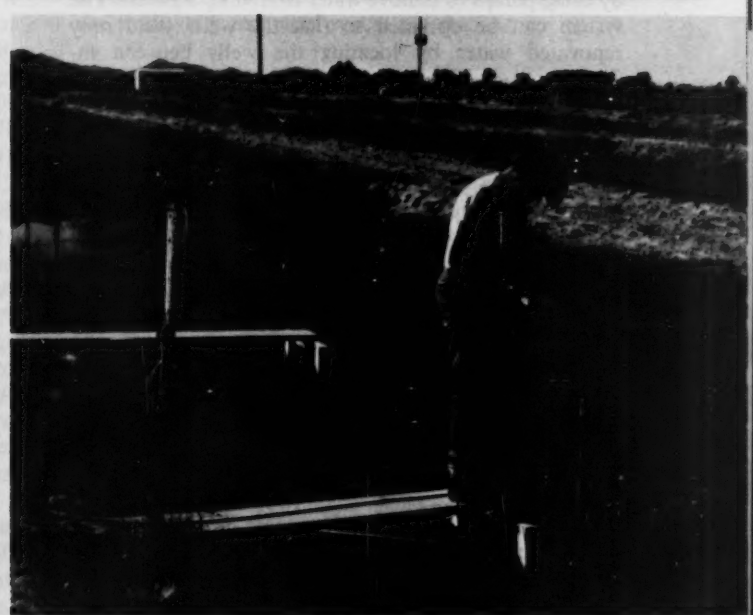
In acid soils, though, phosphate may be more mobile. However, it may be possible to enhance phosphate precipitation in these soils by the addition of lime to increase the pH to above 7. This may also reduce the mobility of some heavy metals. Another possibility would be to dose the effluent with iron chloride or aluminum sulfate (alum) to precipitate phosphate prior to infiltration. The precipitates would then accumulate on the soil surface from where they could be removed by periodic scraping or worked into the soil by cultivating.

Sometimes it may be desirable to reduce the nitrogen and phosphorus content of the effluent prior to land application. This "pretreatment" may range from simple lagooning for nutrient stripping to the more complex in-plant tertiary treatment. In the latter case though, land application would mainly serve as a polishing treatment and underground storage.

Controlling Nitrogen and Phosphorus Removal

Whether or not a high-rate land treatment system should remove nitrogen and phosphorus from the wastewater depends on the intended use of the renovated water. If it is to be used for irrigation, nitrogen and phosphorus

This aerial view of Flushing Meadows Project (below) confirms the laboratory directed control of sewage effluent flow into each basin, such as shown at left.



Above-Measuring water-content profile in soil beneath basin.

Left-About 3 feet of fine, loamy sand underlain by coarse gravel and sand layers is evident in this soil profile photographed at Flushing Meadows.

removal should be minimized because they have fertilizer value. However, a high nitrogen content in irrigation water is not always desired because it may adversely affect the crop. For example, too much nitrogen may cause reduced yield, reduced size, and/or reduced quality of certain fruit crops. It may also delay maturity of the crop, reduce the sugar content in sugar beets, and lower the starch content in potatoes. Excessive amounts of phosphate may aggravate or induce iron and zinc deficiencies in soil.

Thus, the best solution is to be able to control the nitrogen and phosphate levels in the renovated water so that irrigation water of a desired quality can be produced. This control can be achieved for nitrogen by proper scheduling of flooding and drying periods, and for phosphate by properly selecting the distance of underground flow. Both nitrogen and phosphate concentrations in the renovated water can also be reduced by decreasing the infiltration rates in the land treatment system. If the renovated water is to be used for recreational lakes, industrial or municipal purposes, or for general groundwater recharge, maximum removal of nitrogen and phosphorus is desirable.

Minimizing Underground Spread

Another way of minimizing the impact of high-rate land treatment systems on the groundwater is to restrict the underground spread of renovated water. This can be achieved either by locating the infiltration areas on high grounds which drain to a stream or a lake (figure 1) or by using pumps to remove water from deep aquifers. The system can be operated so that the wells yield only renovated water by locating the wells between infiltration areas (figure 2). If a mixture of native groundwater and renovated water is desired (to obtain water of a better quality, for example), wells can be placed on both sides of an infiltration strip or around an infiltration area (figure 3). If the aquifer is shallow, horizontal drains can be employed to collect the renovated water (figure 4). After removal from the aquifer the renovated water can be released into surface water or reused for irrigation, recreation, industrial, or even municipal purposes (with further treatment if necessary).

A certain portion of the aquifer is used as a natural filter in each of the above systems. With proper design and operation, only the portion of the aquifer between the zone of wastewater entry and the zone of renovated water exit will contain "foreign" water. As a general rule, the wastewater should travel several hundred feet underground and have an underground detention time of several weeks before it leaves the aquifer. The proper distance and time depend on the soils, quality of the wastewater, and the desired quality of the renovated water.

In the design of systems like figure 1, care should be taken that the underground flow capacity is sufficient to handle the wastewater flow to the stream or lake. Otherwise the water table will rise and may eventually reach the surface, where it will cause reductions in the infiltration rate and, hence, in the capacity of the system.

For systems such as that illustrated in figure 2, the shape of the water table, the pumping lifts for the wells, and the underground detention times can be predicted by analog or some other technique for a given layout of the system and infiltration rate. By repeating this procedure for various system designs, the optimum design can be selected. Because recharge flow systems in deep aquifers are characterized by active upper zones and passive lower zones, the effective transmissivity rather than the total transmissivity of the aquifer should be used. The effective transmissivity of the aquifer below the Flushing Meadows Project was evaluated from the response of the water table to infiltration.[3]

The water table drop in tile-drained systems, such as that illustrated in figure 4, can be calculated in relation to the geometry of the system, the infiltration rate, and the soil hydraulic conductivity by extending existing drainage theory to include the distance between the infiltration field and the drain.[4] The resulting equation enables calculation of the most economical layout of infiltration areas and drains that will not cause an undue water table rise below the infiltration areas. With tile-drained systems, it may be necessary to settle for shorter underground distances for the renovated water (in the 50 to 100-foot range, for example), particularly in shallow or slowly permeable soils.

Pilot Projects

Since performance of a high-rate land treatment system is dependent on local conditions of soil, climate and hydrogeology—as well as on the waste characteristics—it is desirable to precede any large-scale development with an experimental pilot project when local experience with such systems is not available. Flushing Meadows is such a pilot project for the Phoeniz, Ariz., area. It has been in operation since 1967 as a cooperative effort between the U.S. Water Conservation Laboratory of the Agricultural Research Service, the Salt River Project, and the city of Phoenix.

For the first three years, the project was partially supported by a grant from the Environmental Protection Agency. Based on the results of this project, the city of Phoenix is now installing a 40-acre rapid infiltration system to renovate about 15 million gallons a day (mgd) of secondary sewage effluent for unrestricted irrigation. An existing 40-acre oxidation pond in the Salt River bed will be divided into four 10-acre basins which will be intermittently flooded (figure 5). The renovated water will be pumped from wells on the center dike.

By the year 2000, Phoenix and adjacent cities are expected to produce some 240 mgd of secondary sewage effluent. Reuse of this effluent for irrigation, recreation, and other purposes would reduce the present overdraft

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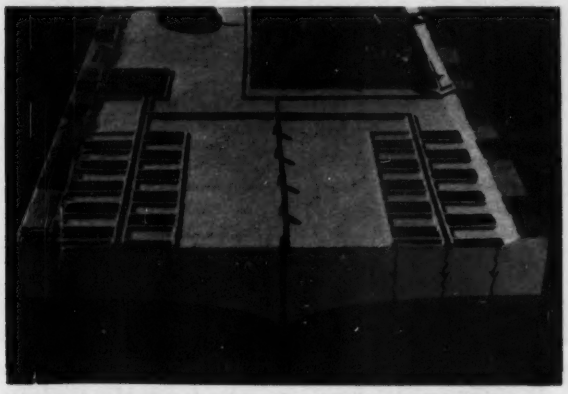
[3]Herman Bouwer; *Groundwater Recharge Design for Renovating Waste Water.* Journal of Sanitary Engineering Division, Proceedings of American Society of Civil Engineers 96(SAI): 59-74, February 1970.

[4]Herman Bouwer: *Design and Operation of Land Treatment Systems for Minimum Contamination of Groundwater.* Proceedings of Underground Waste Management and Artificial Recharge Symposium, New Orleans, Louisiana, September 26-30, 1973. Volume 1, pp. 23-33.

Drying sludgelike solids on the basin bottoms curl into approximately 2-inch flakes that can be "shaved" with a front-end loader.



Model of infiltration basins and wells envisioned for Salt River bed.

on the groundwater. Before the effluent can be reused, however, it should be renovated.

Because the hydrogeological conditions in the Salt River bed are favorable for rapid infiltration, this renovation can most effectively be accomplished by high-rate land treatment. For this purpose, a total of about 1,000 acres of infiltration basins would be constructed along both sides of the riverbed, which is about one-half mile wide, to infiltrate the 240 mgd of effluent. The renovated water would be pumped from wells in the center of the riverbed, making sure that no renovated water would move into the groundwater outside the land treatment system.

The total cost of renovating the effluent in this manner, including pumping it to the surface, is estimated at about $5 per acre-foot or $15 per million gallons. The cost of equivalent in-plant tertiary treatment to produce renovated water of similar quality would be at least ten times as high.

Finally, a word of caution is necessary as to what type persons should design and manage land treatment systems. Required here are the combined talents of the civil-sanitary engineer, the irrigation-drainage engineer, the agronomist, the soil scientist, and the geohydrologist. Ken Wright, as quoted by Kneeland A. Godfrey in the September 1973 issue of *Civil Engineering*, states that, "Perhaps for this reason alone, the sanitary engineering professionals have been somewhat recalcitrant (towards land treatment) knowing that the overall design control of such a project might necessarily fall into the hands of a generalist, or a water resources planner, rather than the traditional technical specialist."■

New Era for Land Treatment

Land treatment as an acceptable method of water renovation has come a long way since our series on the subject began in 1972. And we like to think that information and ideas in the series have contributed to that acceptance.

Our first article on land treatment was by Melbourne, Australia authors S. S. Searle and C. F. Kirby. They discussed their city's 80-year experience in using raw effluent on agricultural lands. The article, "Wealth into Waste," appeared in the 1972 Vol. 4, No. 3 issue.

Dr. T. D. Hinesly then wrote an article for us entitled "Sludge Recycling: The Most Reasonable Choice?" It appeared in the 1973 Vol. 5, No. 1 issue at a time when people had "growing compunctions against having partially treated sludge dumped into our streams and oceans." The author emphasized that "burning, dumping or permanent lagooning is sheer waste of a valuable resource."

In the next issue, Vol. 5, No. 2 of 1973, Dr. Hinesly described "a wastewater recycling system devoid of objectionable features." He pitted land treatment and water re-use against traditional wastewater disposal into the Nation's waterways. He explained the advantages of the spray irrigation method.

Dr. P. G. Hunt of the Corps' Waterways Experiment Station (WES) at Vicksburg, Miss., wrote our next land treatment article. He explained the overland flow system, drawing on experimental work being conducted at WES.

In this issue, Dr. Bouwer's discussion of the rapid infiltration/percolation system completes our coverage of the three main land treatment methods and their applicability under different conditions.

Now, the use of land treatment methods is entering a new era: beginning July 1, 1974, the Environmental Protection Agency will require any community that applies for a waste treatment construction grant to show that it has considered all alternative methods—including land treatment.

You may want to see EPA's findings from their study of current knowledge and techniques of land treatment. They have published two volumes on the subject entitled Wastewater Treatment and Reuse by Land Application—Volume I—Summary (EPA-660/2-73-006a) for $1.10 and Volume II (-006b) for $2.40 available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., 20402. Volume II is a supporting document for the Summary and also lists 142 references.■

"State administration of land use management programs takes on greater significance when one recognizes that the traditional instrument of control—zoning—has just as traditionally proven inadequate..."

Land Use: A Challenge to State Leadership

by **R. Deane Conrad**
Special Assistant
The Council of State Governments

The title of this article was written almost three decades ago. It appeared in the October 1945 issue of *State Government* magazine which was devoted entirely to the subject of land use. The introduction contained a statement which explained the necessity of State involvement in any efforts to improve decisions as to the use of land and also set forth the basic relationship in this field between States and the Federal Government: *The States under their general power to legislate on behalf of the public health and safety are able to deal directly with a variety of problems affecting land use, whereas Federal jurisdiction is frequently indirect often requiring State implementation!*

There is, of course, another level of government in the theoretically tiered system of American Federalism. Most decisions regarding land use in 1945, as in 1973, were made by local governments. Under virtually every new land use reform proposal being considered in the State or national legislatures, that would continue to be the case. Nonetheless, major emphasis would be placed upon greater State level participation in the process of determining the future use of land. For the forces that prevailed over the past few decades, perhaps even centuries, have put our future in jeopardy.

For example, the President's Citizens Advisory Committee on Environmental Quality asserted in a recent annual report:

Of all the factors which determine the quality of our environment, the most significant is the use we make of our land.

Far more than the physical environment is at stake. The socio-economic forces which exert so powerful an influence on land use decisions are in turn profoundly changed by those resulting conditions. Patterns of community growth and human settlement may serve a society well or ill. They touch all lives in countless and varied ways. They affect fiscal resources for public facilities and services, job opportunities, pollution control, housing, recreational activities, transportation, agriculture and many others.

In less crowded, simpler times, it did not matter much how the abundant land resources of this Nation were used. Land was a speculative commodity to the Colonial settlers. It remained in abundant supply all through the last century. As late as 1864, the Homestead Act offered a settler 160 acres for a $10 filing fee. Few are aware of the rate at which open space is being lost to urban growth, over 1,000 square miles every year. Much of this is prime agricultural land. But the heaviest development is occurring where the majority of people already live. It is becoming increasingly evident to a larger number of individuals that the land supply is limited and that efforts must be made to conserve what remains and make the best use of those lands needed for future development.

Despite the recent decline in the U.S. birth rate, population estimates still project an additional 50 million people before the end of this century. At the current rate of 27,000 new "households" each week, the rate of subdivision development is likely to increase even beyond present demands.

Nonetheless, in spite of a growing sense of absolutism in the rights of individual landowners to the use of their property, certain restrictions always applied. Among these were the general nuisance statutes which forbade actions that might disturb a neighbor or the public, and the ubiquitous, if tentative, police power of taxation. In

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Mr. Conrad is presently on loan to the Federal Energy Office, serving as State Liaison Officer.

Left-Direct State statutory control over specific "critical areas" is most likely to occur in order to curb abuses such as this release of mine acid into a stream.

EPA-DOCUMERICA Bill Gillette

Below-In some coastal States the construction of artificial reefs would be considered under land uses within a geographic area such as shorelines or wetlands. Designation of geographic categories for land use is one of the more common State approaches.

EPA-DOCUMERICA Flip Schulke

Above-This distinctive road pattern for a recreation area represents a form of growth which a land use system must recognize as one of its elements.

EPA-DOCUMERICA Bill Reaves

Left-Land use systems must take into account such matters as low energy transportation between production sites and markets.

EPA-DOCUMERICA Gene Daniels

Growth is no longer considered an unalloyed benefit. Too often the dynamic forces which precipitate and shape growth also dictate future land use.

EPA-DOCUMERICA Frank Aleksandrowicz

fact, constraints on land use were imposed by the Colonial government on the settlements of Jamestown and Plymouth in the 17th century.

It was the pressure of unprecedented urbanization that provoked new measures of control in the early decades of this century. The debate over zoning, restriction without "due process" compensation for the taking of property, was not settled until the U.S. Supreme Court ruled in the 1926 case of *Euclid* v. *Ambler Realty Company* that:

States are the legal repository of police power. (An) enabling act for zoning is the grant of this power to a municipality for regulating the height, area, and use of buildings, and the use of land. In the exercise of this grant the regulations must be reasonable and not arbitrary or discriminatory. They must have a substantial relation to the health, safety, morals, comfort, convenience, and welfare of the community.

Early State actions in land use, however, focused on rural areas, particularly in the establishment of conservation districts. It was not until 1961 that the first comprehensive statewide zoning plan, administered by the State itself, was enacted into law by the legislature of Hawaii. The legislation established a program which divided all the land in the State into three classifications: agriculture, conservation and urban. Later a fourth classification, rural district, was added. Policy was determined at the State level, but implementation requires cooperation of both State and local governments.

Since the early example of Hawaii, the number of States which have adopted major land use planning programs has risen to thirteen. They include California, Colorado, Delaware, Florida, Maine, Massachusetts, Michigan, New York, Oregon, Vermont, Washington and Wisconsin.

In a broader sense, virtually every State has begun to exercise some measure of control over land use decisions of various kinds. Most of these are single purpose efforts to deal with particular problems. Such measures include floodplain management, wetlands protection, power plant siting, scenic rivers preservation, historic preservation, strip mining regulation, subdivision control, erosion prevention, and low cost housing development. Most of the 30 coastal and Great Lakes States have begun efforts to protect and manage their shorelines.

During 1973, seventeen States passed new laws to deal with land use problems. Major legislative initiatives failed in fourteen States, but will almost certainly be reintroduced in succeeding legislative sessions.

Under this broader description of State land use activities, the following States should be added to the thirteen enumerated above as having enacted new legislation: Arizona, Arkansas, Indiana, Minnesota, Mississippi, Montana, New Jersey, New Mexico, North Carolina, North Dakota, South Dakota and Wyoming.

Initial zoning efforts were prompted mainly by economic considerations. They were attempts to maintain property values against the degrading effects of incompatible uses. Rapid urbanization and uncontrolled development and sprawl, however, have prompted a new public awareness which is adding further dimension to decisions on the use of land. Social and ecological concerns must now be factored into land management systems. Growth is no longer universally considered an unalloyed benefit.

For many reasons, local jurisdictions have been unable to implement comprehensive land use management programs or exercise effective control.

Most local governments simply do not at present have the necessary expertise and manpower to develop and carry out sophisticated land use programs. Even where they do, there is a strong economic disincentive against limiting new development within their jurisdictions. The fiscal resources needed to fund public services and facilities construction are derived largely from property taxes. Without new opportunities for employment, local citizens may leave the city. If they remain, the burden is even greater. For instead of contributing to revenues through sales taxes and the like, they may end up on the welfare rolls. Even where this is not the case, local perspective is seldom broad enough to encompass statewide or national interests in the decision-making process.

State involvement, therefore, is not only a constitutional but a practical necessity for instituting reforms in the way land use controls are exercised.

As indicated above, many States are already beginning to execute that responsibility. They are doing so in a variety of ways, ranging from the direct exercise of zoning power over all lands within the State to the review of specific local actions.

While land resource management has many facets,

Terrain abuses call attention to the need for better land use systems.

EPA-DOCUMERICA David Hiser

there are generic elements which, in one form or another, must be part of any coherent State process. The first of these, of course, is the adoption of policies for the general priorities and uses of land resources. The policies would then serve to guide the preparation of appropriate land use plans. Institutional and organizational arrangements would have to be made for coordinating and administering the programs both intra and intergovernmentally. Finally, the means for implementing and enforcing the programs must be established.

In the ultimate sense, no State has yet accomplished all of these elements completely, though a few are coming near.

For example, Hawaii's officials have gone through all the exercises cited above. They began with a policy aimed toward the conservation of their farmland. It did not protect them from the rampant development of Honolulu and the beach at Waikiki. They are, however, in the process of reviewing and revising their program to accommodate changes and pressures that were not foreseen even so short a time ago as 1961 when the Hawaii State Land Use Law was enacted.

Vermont, like Hawaii, assumes the responsibility for managing general land uses within the State.

But there are other categories of control such as that exercised by Maine and Massachusetts which provide for approval of land use development within the State in accordance with functional criteria such as environmental protection or housing development.

Another common approach, and the principal category emphasized in pending Federal legislation, is the management of land uses within geographically specified "critical areas," including wetlands, shorelines, seismic risk areas, floodplains and the like. Delaware, Maine, Massachusetts, Michigan, Vermont, and Wisconsin have engaged in this kind of activity. They are joined now by California, Florida, Minnesota, Mississippi, Montana, New Jersey, North Dakota and New York.

The least complex category of State land use activity is the enactment of zoning or subdivision authority in the absence of local ordinances or regulations without reference to statewide plans or standards. Arizona, New Mexico and Oregon fall in this category.

Obviously, the categories are not exclusive. In fact, movement seems to be in the direction of the second and third categories, critical areas and functional areas of greater than local concern. If enacted, the proposed Federal legislation would require States to engage in all but the first category of activity, comprehensive statewide land use management.

another way of viewing State involvement in land use management programs is through the nature of their control. The first order is direct statutory control exercised by the State. This is likely to occur only in specific critical areas and apply to specific activities such as strip mining. It will affect only a small percentage of all land use decisions, most of which will continue to be made at the local level.

Recognizing this fact as well as the need for "improved" local decisions, the basic State administrative structure for land use will consist of guidelines and criteria for city, county and regional government procedures which may, in some instances, include the right of State intervention if local governments fail to implement proper procedures or exercise effective controls.

In order to overcome intergovernmental conflicts, provide for greater public involvement, and ensure

EPA-DOCUMERICA Charles O'Rear

Land use policy for some States began with the conservation of their farmland, but that alone did not prevent rampant development.

broader perspective yet retain sensitivity to local concerns, a third order of State control is being developed. This is manifest in emerging mechanisms for joint action such as the State-local commission established by the California Coastal Conservation Commission proposal enacted last year. A number of States have set up such commissions to administer a variety of programs. The pattern differs among the States, reflecting dissimilar laws and traditions, especially regarding State/local affairs.

While the commission mechanism may be politically expedient, it has yet to be fully tested as the ultimate device for land use determination. Even the most advanced States have not created integral planning for land use incorporating agricultural policy, transportation systems, industrial, commercial and housing development and the many other factors necessary to wise planning but still more important to its successful implementation.

The question of State administration of land use management programs takes on greater significance when one recognizes that the traditional instrument of control—zoning—has just as traditionally proven inadequate even for the limited purposes to which it is put. As suggested above, zoning is not planning. It is a protective measure for maintaining or enhancing existing land values. It has value as a device for restricting development. But it is virtually impotent when balanced against the dynamic forces which precipitate and shape growth. Principal among these, of course, is economics. The money factor operates to impel long term capital investment in land development activities which exert overwhelming pressures on local officials. Whatever resistance a community may have is overcome by its reliance on property taxes for financing public services and facilities. If zoning designations were unassailable, they would do little to solve our land use problems.

A land use management system is deficient if it can be used only to limit or restrict growth and development. It must be able to encourage and direct growth. Growth, at the present time, must be recognized as inexorable. Population forecasts suggest that, even if the birth rate declines below the current replacement level, the population will continue to increase until the second decade of the twenty-first century. If the total population level remains static from that time on, there will still likely be shifts in its distribution. For many additional reasons, including economic and resource considerations, it may still be desirable or necessary to allow or assist new development activities.

It may be imperative to move energy production facilities closer to fuel sources, or factories closer to energy sources, or workers closer to factories. As personal incomes increase, the demand for vacation homes grows. So too the need for more recreational facilities. Increased affluence provokes changed living patterns and consumer demands which are inevitably space intensive. This multiplier effect places a heavy burden on land and natural resources. It places a heavy burden on social and environmental quality. For the general public good, governments must act to ease that burden.

The willingness of State, county and local officials to do so is evidenced by the increasing numbers of actions being taken in all parts of the Nation. Some of those have been described in this article. Further indication of that resolve may be taken from the policy positions adopted by the national organizations of State and local officials, the National Governors' Conference, the U.S. Conference of Mayors and the National Association of County Officials. In their policy positions, governors, mayors and county commissioners endorsed the concept of land use planning as a means for allocating scarce resources.

The leaders of these organizations have formed a "New Coalition" to work for a more effective and responsive Federal system of government through a strengthened State and local role in that system. Under the "New Coalition" they have proposed joint action for land use planning, including development of a national program with Federal assistance to State and local governments for developing and carrying out land use management programs.■

on a flood plain

can a right go wrong?

by George R. Phippen, Chief
Flood Plain Management Services
Directorate of Civil Works
Office of the Chief of Engineers

Where flood plain use is involved, the individual's legal relationship to the community raises many issues. Foremost is the concern that individual rights will be unnecessarily eroded by community actions, and this issue often frustrates those who are seeking land use solutions.

Yet ordinances are essential tools of flood plain management because the absence of regulations invites individual actions that could have an adverse effect on the entire community. Thus, the flood plain offers a natural basis for use of police power to make individual actions conform to standards.

As I stated in the Summer 1971 issue of WATER SPECTRUM, the individual's right to land is not a right to charge his costs off to others.[1] Individual land rights tend to disappear in direct proportion to increasing flood hazards. An occupant of the flood plain—*an area that has been, or could be, flooded*—may increase the flooding hazard directly by exercising various private options. He can sell, use or develop his land in a manner which eventually costs the community. When the actions are incompatible with flood plain conditions they often appear at some later date as a public nuisance, threat to public safety or lead to victimization and fraud.

External costs always occur *in the occupancy* of a flood plain. Therefore, under common law, the key question becomes: When do these shifted costs become unreasonable? A judgement on this is made by the community through enactment of ordinances guiding development and tailoring specific uses to conditions of the flood plain.

To understand where this authority comes from we return to the basis for all the Nation's police powers—the sovereignty of each individual State. Each State normally delegates some of its authority to local units of government. Application of the police power to land uses is no different than its application to the use of motor vehicles or to crimes against property and persons. Thus the community, operating under State enabling legislation, can prohibit individual actions that would constitute a nuisance or threaten the public safety.

Two Types of Losses

Individual actions on the flood plain can result in two kinds of losses. First, the individual who enters the flood plain invites flood losses to himself regardless of the specific use he makes of the flood plain. Clearly some uses are more vulnerable to floods than others. The potential for loss varies widely. Society always feels compassion for the person who suffers flood loss even though the loss is due to his own acts. Yet mandatory

[1] "A New Course to Ararat," pp. 8-15.

protection against personal loss or injury from these acts is a secondary consideration for flood plain regulations.

It is the other type of loss that forms the basis for most flood plain regulations. This loss results because the individual shifts some of his costs of flood plain occupance to others. This shift may come in the form of higher flood stages caused by impeding or obstructing the normal pattern of flood flow. Each new flood plain use can result in flood depth increases not only for flood plain neighbors, but also for residents outside the area who otherwise would not be flooded. The occupant may also shift the costs to the community for those services (utilities, streets, *et al*) which are supplied to him. These costs may be either for flood losses to the facilities or flood proofing expenses.

Furthermore, the most productive fish and game habitats are among the unique flood plain attributes which are displaced by encroachment of other uses. Other costs—such as relief and rehabilitation, or protective works that society feels compelled to provide—are no less important.

1.1 STATUTORY AUTHORIZATION

The Legislature of the State of _____ has in _____ (section of statutes) delegated the responsibility to local governmental units to adopt regulations designed to minimize flood losses. Therefore the _____ (governing body) of _____ (local unit), _____ (State) do ordain as follows:

1.2 FINDINGS OF FACT

***1.21 Flood Losses Resulting from Periodic Inundation.*—The flood hazard areas of _____ (local unit), _____ (State) are subject to periodic inundation which results in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base all of which adversely affect the public health, safety and general welfare.**

***1.22 General Causes of These Flood Losses.*—These flood losses are caused by: (1) The cumulative effect of obstructions in flood plains, causing increased flood heights and velocities. (2) The occupancy of flood hazard areas by uses vulnerable to floods or hazardous to others which are inadequately elevated or otherwise protected from flood damages.**

***1.23 Methods Used to Analyze Flood Hazard.*—This ordinance relies upon a two-step process for reasonably analyzing the flood hazard affecting specific lands. The official zoning map adopted as part of this ordinance (Section 2.2) provides the first step by delineating a General Flood Plain District determined to be subject to flooding based upon evidence of past flood [illegible] has [illegible] delineate the [illegible] the proposed use.**

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It is the purpose of this ordinance to promote the public health, safety, and general welfare and to minimize those losses described in Section 1.21 by provisions designed to:

The "regulatory flood" is a flood of a specified magnitude, a "large" one, adopted as the basis for ordinances or statutes.

Lastly, and certainly not least from the standpoint of a legal nuisance, is the cost imposed upon neighboring lands when the use-form (house, barn, shed) itself floats off its foundation and becomes a destructive weapon against other property during a flood.

Not only buildings but such items as lumber piles, chicken coops or tanks cause such damage—either through collision or by creating temporary dams. Materials such as caustic or poisonous pollutants, or explosive materials dislodged from their storage areas may create a serious nuisance and a threat to the public safety.

The point is that it is reasonable to assume that the more frequently flooded portions of the flood plain—those defined within a 100-year floodway—have sufficient certainty of flooding that the consequences described above would be deemed nuisancelike by a court. Even the floodway fringe qualifies under some circumstances. Courts commonly assume that there is a cumulative effect on flood heights caused by like entries into the flood plain. Courts also assume an equal degree of encroachment for each entry when judging the consequences of flood plain use.

Dr. Jon Kusler,[2] an attorney who recently conducted a series of regional seminars on flood plain regulations for the Corps of Engineers, has made a study of past court actions. Based on these studies, Dr. Kusler concluded that the courts invariably give support to flood plain ordinances designed to prevent threats to the public health and safety, nuisances, victimization or fraud. In fact, some courts have ruled that even if the only possible economic use of land would create a nuisance, the individual still has no right to such use. Hence, neither does a case for a "taking" exist if such use is prevented. Likewise, public occupation of apartments and motels inviting the public into a flood plain may cause the issue of public safety to weigh heavily in the balance of justice.

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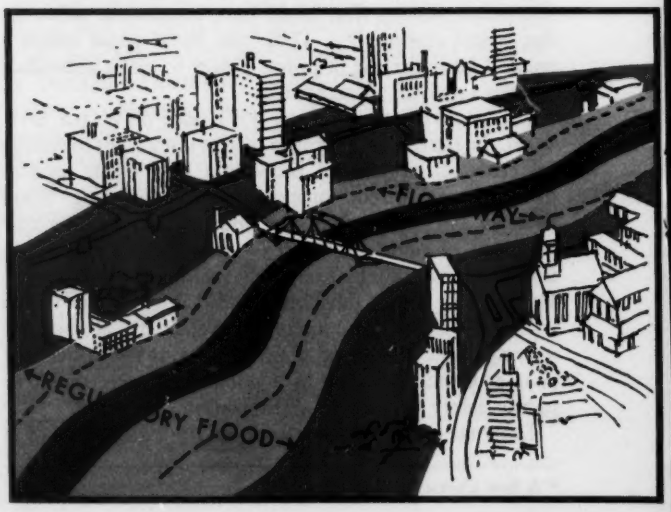
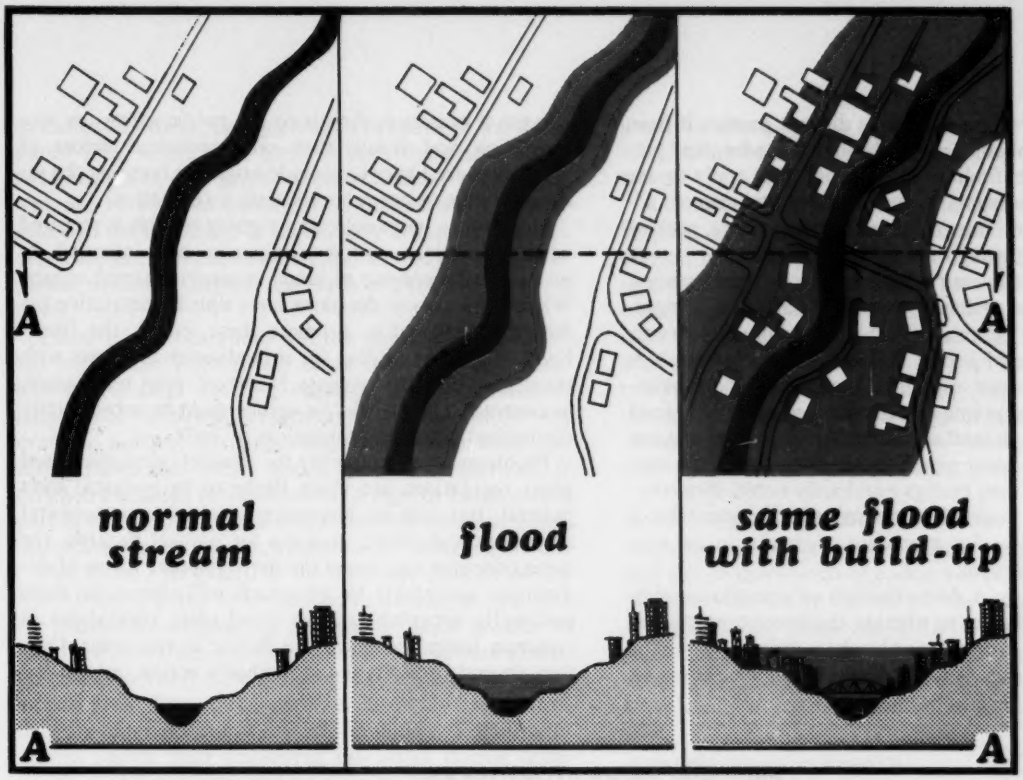




Building in the flood plain can make floods wider and deeper.

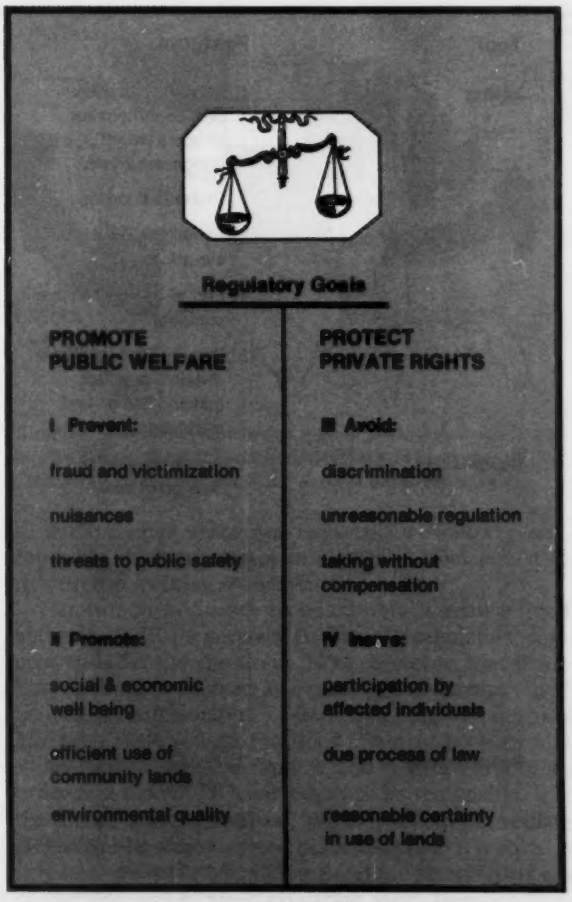
The police power of the State protects both private rights and the public welfare. In this context, two points should be made. First, flood plain regulations *per se* cannot be used to change land from private to public ownership and use; second, they apply particularly, but not exclusively, to the future. They are a necessary part of the flood plain management process which seeks optimal use of lands.

A flood plain management program should be thought of as a continuing process of planning, implementation and operation. Proper management may require adjustments of all kinds once it is accepted that the flood plain's given role is conditioned by its assets and liabilities, and the future of its surrounding territory. These adjustments may involve changes in either horizontal or vertical land use, modifications via flood control, or by rehabilitation.

Constitutionality

Whenever flood plain regulations are enacted into State statutes or local ordinances, they are presumed to be constitutional. This puts the burden of proof on the individual in regard to showing injury and unconstitutionality. The courts must then determine whether the goals and objectives of these laws are justified when weighed against the loss of individual rights.

In reality, a whole statute or ordinance is rarely tested in the courts. Rather, the test is made as to whether the law in question deals too severely with the individual. This approach stems from the second of the last two rulings by the Supreme Court of the United States on zoning regulations. After the court first ruled in the mid 1920s that zoning laws were a legal application of police power, they ruled in a second case, a year later, that the



protection against personal loss or injury from these acts is a secondary consideration for flood plain regulations.

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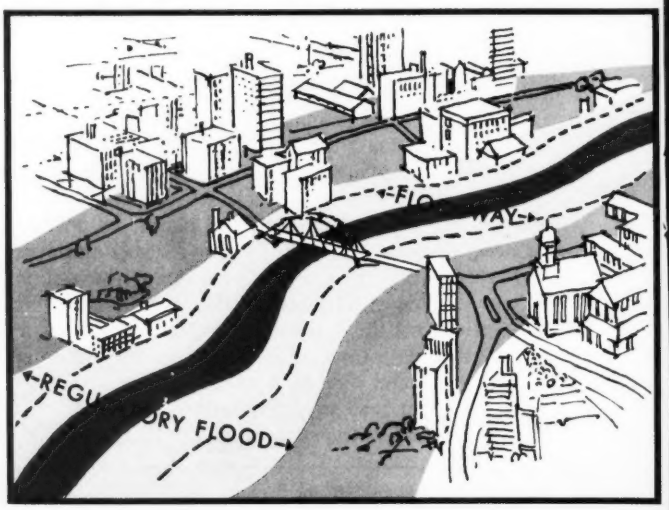

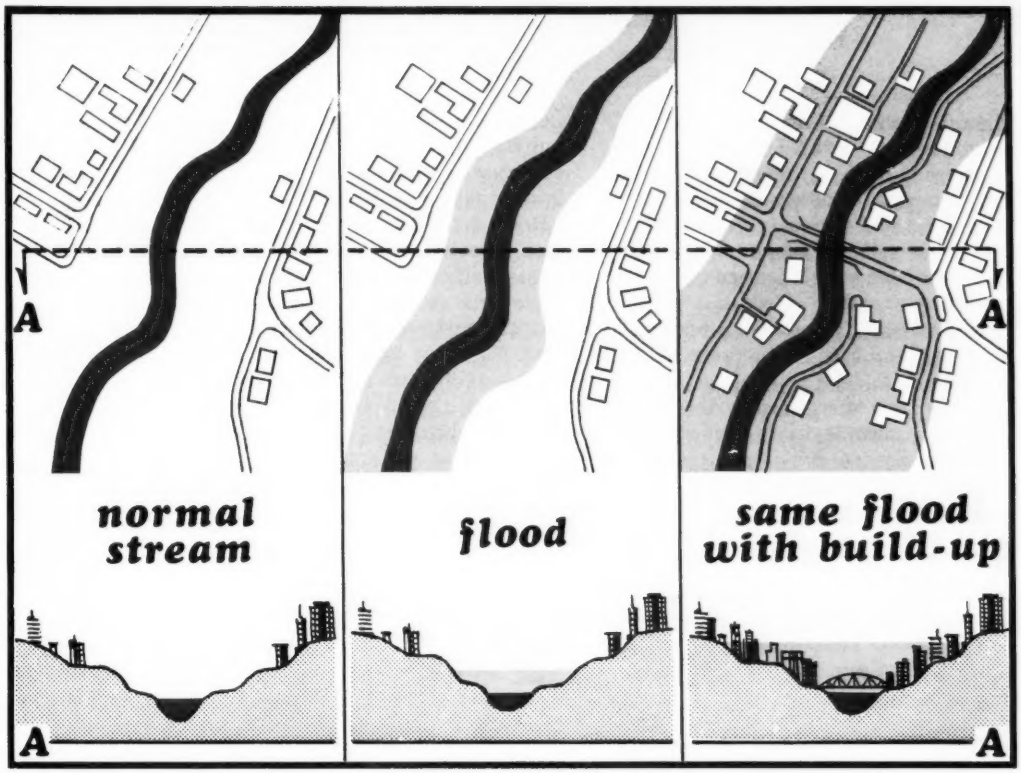

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Regulatory Goals

PROMOTE PUBLIC WELFARE	PROTECT PRIVATE RIGHTS
I Prevent:	**III Avoid:**
fraud and victimization	discrimination
nuisances	unreasonable regulation
threats to public safety	taking without compensation
II Promote:	**IV Insure:**
social & economic well being	participation by affected individuals
efficient use of community lands	due process of law
environmental quality	reasonable certainty in use of lands

general validity of an ordinance did not protect it from attack when applied to particular lands. Under this "pinpoint" approach, findings of invalidity that apply to one property may not apply to another property, even an adjoining neighbor. Thus the next door neighbor, seeking relief, must go through the same process.

The fact that the courts have not recognized creation of a nuisance or a threat to public safety as a right, makes one thing rather obvious: if an ordinance prevents potential threats of injury and loss to the public it is likely to be sustained, even if severely limiting on the individual. State supreme courts are generally the final court of appeal in land use cases and it is their rulings which have the most significance, other than the two U. S. Supreme Court rulings previously noted. Nonetheless, while State courts look to decisions in other States on similar matters for precedent, they are in no way bound to follow them.

It boils down to a determination of constitutionality by individual judges as to whether the restrictions placed on an individual are balanced by the public good. As Dr. Kusler pointed out, if an ordinance can be shown to prevent a nuisance, threats to the public safety, or victimization and fraud, then only technical errors of procedure are likely to provide litigation favoring the individual landowner who contests a regulation.

However, a more delicate weighing of facts is required when provisions of an ordinance are intended to promote efficient use of lands or environmental values. While some recent decisions have upheld restrictive ordinances designed to promote these values, the likelihood of a court finding for a landowner increases with the degree of restrictiveness. However, even real values, as contrasted to *speculative* values, must be substantially diminished before a "taking" is at issue.

Problems of acceptability for properly designed flood plain regulations are more likely to be political than judicial. But with an increasing level of environmental awareness and public concern for natural hazards, the same concerns that make the more popular forms of ordinances acceptable to the courts will also make them politically acceptable. Most flood plain regulations in common usage recognize this factor in two ways. One, they severely restrict the individual's action only in the

PRINCIPAL REGULATORY TOOLS

Tool	Features	New Uses	Existing Uses
Zoning	1. Regulates all uses. Sets conditions for all users within flood plain zones. 2. Protects floodway. 3. Establishes protection elevations. 4. Part of comprehensive planning. 5. Does not regulate land division, detailed building design and materials.	1. Wide potential in regulating building, land alterations, cutting, many other features. 2. Usually prior comprehensive plan required. 3. Extraterritorial application in some States, but procedures often complicated.	1. Some potential in eliminating nuisance floodway or flood fringe uses. 2. Requires existing uses be brought into conformity if abandoned, destroyed or substantially repaired.
Subdivision	1. Applies to sale and division of land.	1. Wide potential in requiring disclosure of flood hazards, insuring lands will be suitable for intended purposes, and requiring installation of public facilities by subdivider. 2. Extraterritorial application common. 3. Useful for urbanizing areas.	None
Building Code	1. Applies to design and materials. 2. Does not in itself regulate type of land use. Poor in protecting floodway.	1. Wide potential in establishing detailed construction standards.	Usually none

so called floodway, or high hazard portions of the flood plain. Two, at the same time, in the remaining areas of the flood plain, they permit reasonable uses—ones which will not be obvious nuisances or threats to the public safety in time of flood. It is generally accepted that certain uses, like general hospitals and atomic energy power plants, should be beyond the reach of flood waters at all times.

Flood plain regulations are not aimed at uses *per se* but rather the pattern and form that such uses take. Residential land use, for example, is not precluded. Residential yards and gardens could be compatible with even the strictest of regulations. On the other hand, the associated houses either would have to be elevated, if they were situated in the floodway fringe, or built on that part of the property that extends beyond the flood plain, depending on the exact circumstances being regulated.

Not to be overlooked is the certainty that all of the flood plain is going to be flooded at some time, and that the hazard accompanying any use is much greater in some portions than in others. Thus, the process of identifying the floodway zone is a way of separating the higher hazard areas from those of lower hazard. It recognizes that the latter portions of the flood plain are essentially *storing* rather than conveying the water during large floods, that this storage can be given up in favor of structures, fills or some other use to the extent that such use would not cause a significant increase in flood depth. It is in the *conveying* portion, or floodway, where the potential for high loss and shifted costs occurs, particularly when buildings are present.

Once a community has completed identification of the high hazard or floodway areas, it has gained the type of knowledge necessary for intelligent issuance of building permits for the less hazardous fringe areas of the floodway. It will have learned by then what elevation and other flood proofing safeguards are prerequisites along with provision of access ways secure from high waters.

A basic difference between regulations and the visible forms of protection, such as dikes and walls, is that the former are not likely to induce uses incompatible with a residual flood threat. Visible dikes and walls, such as those which may have been built in earlier years within the floodway to protect communities against smaller floods, tend to encourage a false sense of security.

Similar identification of high hazard areas is possible along coasts subject to tidal or lake flooding and the major wave attacks, high velocity currents and significant levels of erosion that accompany floods. Coastal sections located inland of the high hazard area, yet still flood prone, can be viewed in much the same manner as a floodway fringe zone.

Compatible Taxing Policies

Even if the tax laws have to be changed, taxing policies must be brought into harmony with the purposes of flood plain regulations. Thus, low rates of taxation would apply to areas zoned for low intensity or open development. Although these regulations tend to be urban-suburban oriented, much of the land under pressure for development is often agricultural. Communities are prone to overlook this relationship and force eventual subdivisions of open lands by escalating their tax assessments

A related matter which compounds this problem is the frequent assumption that taxes on the new use of subdivided land will offset the cost of required community services. This is generally an erroneous assumption unless the new use has a very high value-to-services ratio. Such a mistaken assumption is particularly likely where the new subdivision is put into housing use, even in those cases where initial facility cost is passed on to the buyer. To help avoid this type of mistake, the zoning of current agricultural and low-density areas can be reinforced with compatible taxing policies.

Tailoring Regulations

Since the purpose of an ordinance is primarily to regulate one or more areas of concern to public well being, it must be reasonably related to these concerns. For although an ordinance can achieve more than one objective, say property loss reduction and maintaining open space, its regulatory purpose related to floods should not be diluted. An example of dilution would be an attempt to achieve open space not required for floodway and, following this, an attempt to change it from public to private use without compensation.

States With Standards Based On "Large Flood" For Flood Plain Ordinances

Some 18 States have standards for flood plain regulation based on the "large" flood. In addition, enabling legislation in all 50 States explicitly or implicitly permits local regulations.

Nor can an ordinance be based on too small a flood and still fulfill its purpose. In fact, the regulatory concept calls for a *large* flood. Note, however, that if too large a flood is adopted as a guide the ordinance could be judged unreasonable. There is one large flood which has been widely used for flood plain ordinances and statutes, by common definition, and is apparently of an order that the courts have judged to be reasonable. It is the so called *100-year flood.* We call it the Intermediate Regional Flood in our flood plain information reports. It is recommended as a guideline flood for planning the use of the flood plain when preparing regulations.

However, tighter restrictions may need to be extended into the floodway fringe wherever local conditions warrant. Merely recognizing a 100-year flood potential will not guarantee prevention of catastrophic consequences in the fringe areas if the latter are unregulated and appear to be both ripe for development and subject to severe, additional flooding from very large floods. There are just no hard and fast rules when dealing with the fact that yet greater floods may occur in the future.

Recognition of the 100-year flood signifies a flood that has a 100 percent probability of being exceeded at some time in the future. It has a 1 percent probability of being exceeded every year. As indicated in the Summer 1971 issue of WATER SPECTRUM,[3] one could say this flood has a 20 to 30 percent chance of being exceeded within the average mortgage life of many buildings. Such odds might seem long at the race track, but take on a different, more sinister meaning when they relate to life and limb and livelihood.

Note also that a much larger flood is suggested by responsible planners for the design of flood control works in both urban and urbanizing areas. Such works tend to induce growth and could lead to catastrophic losses if they fail.

Several States now have new or recently revised statewide programs for flood plain regulations. Add to this the obvious influence of the National Flood Insurance Program, which requires that communities adopt land use controls for continued insurance eligibility, and the fact that over 800 locations covered by Corps flood plain information reports are now under flood plain regulations, and the evidence says: flood plain regulations have come of age. The December 1973 amendments to the insurance law will goad communities into entering the program at an accelerating rate—contributing even further to the proliferation of local flood plain regulations.

Federal Involvement

Although the Federal government has no direct regulatory powers *vis-a-vis* private lands it can exert considerable pressure. Enactment of a National Land Use Policy bill for example, would induce regulatory program action by each of the States and the respective localities within them.[4] The requirement for land use controls under the existing National Flood Insurance Program has already been cited, and the Corps now considers needed flood plain regulations as prerequisites for local cooperation prior to Federal investment.

Closely related, but not a regulatory process as such, is Executive Order 11296. The intent of this executive order is to avoid uneconomic, hazardous and unnecessary use of the Nation's flood plains. It therefore charges Federal agencies with the responsibility of recognizing the inherent flood hazard involved before decisions are made to develop, sell or dispose of flood plain lands, or to grant or loan funds for development in such areas.

FEDERAL INVOLVEMENT under EXECUTIVE ORDER 11296

State	Agency	Property	Adjustment
Arkansas	EDA	Industrial site	Proposed site abandoned
California	FHA	Residential/Commercial	Proposal abandoned
California	HEW	Hospital	Elevated and ramped
Colorado	GSA	U.S. Mint	Elevated on fill above very large flood level
Florida	GSA	Land disposal	Notation of flood levels
Georgia	HUD	Housing project	Withdrew support
Louisiana	HEW	Library	Elevated and ramped
Mississippi	FHA	Subdivision	Elevated to large flood level
Missouri	HUD	Housing for elderly	Flood proofed building and access
New Mexico	EDA	Industrial sites	Elevation, flood proofing and site modification
Nevada	HEW	University building	Raised floor levels
North Carolina	HUD	Public housing	Changed site
Oklahoma	HUD	Housing renewal	Stopped and relocated
Texas	*FHA*	Home	Mortgage assistance denied
Virginia	HUD	Public housing	Changed site

EDA - Economic Development Administration
FHA - Federal Housing Administration
FHA - Farmers Home Administration
HEW - Health, Education and Welfare
GSA - General Services Administration
SBA - Small Business Administration

The Corps was given the role of supplying flood hazard information requested by other Federal agencies, but was not charged with monitoring the use of such data. However, review of the information available suggests the widespread effectiveness of this program. We responded to 3000 requests for information in 1970. By 1973 the responses from all sources numbered over 9600. In both of these years about a third of the requests came directly from Federal agencies and at least another third appear to have come indirectly from those seeking Federal financial assistance. The remaining third were apparently not related to the executive order. Interestingly, some of the States have followed the Federal example by issuing similar executive orders.

Prospects

Attitudes about land and land use have changed quite dramatically over the past few years. *Once the flood problem has been defined in factual terms, it no longer appears as a so called act of God—a labeling of events which serves only as an excuse for regulatory inaction.*

Attitudes are also changing in response to the increasing urban-suburban interest in flood plain management. The need for new regulations in the management

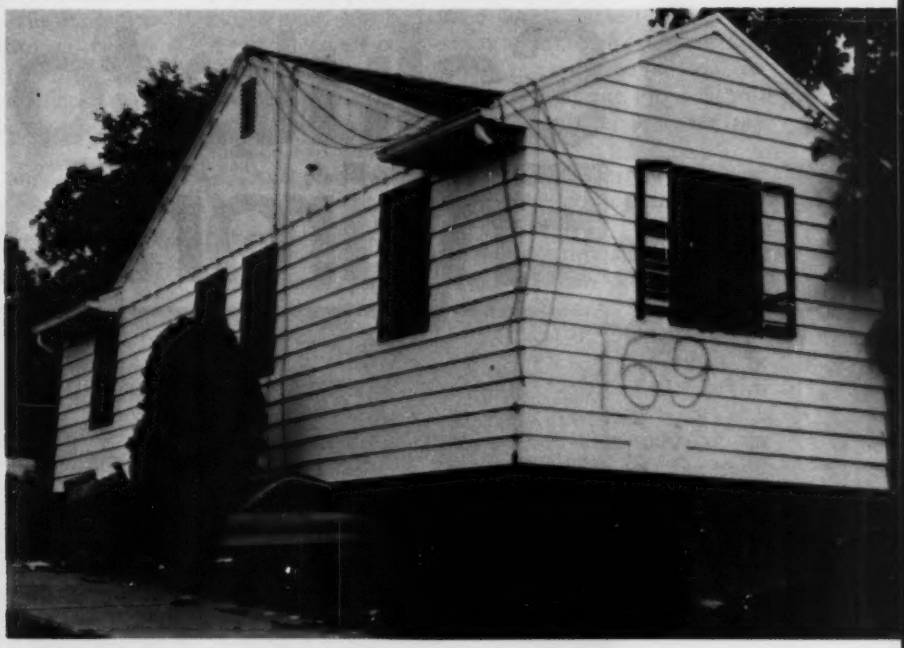
[3]See note 1.

[4]See *Land Use: A Challenge to State Leadership*, beginning on page 26 of this issue.

Left—Failure to provide enough "opening" for flood waters becomes starkly evident from the naked bridge supports.

Below—Houses washed off foundations become threats to neighboring property.

Below left—Human compassion for those who suffer most translates into a cost shifted to the community during periods of relief and recovery.



process is being recognized concurrently at all levels of government. But meanwhile, encroachment continues. The seriousness of flood problems increases. The occupiers lose. The communities and the Nation lose. The need for land use regulations becomes ever clearer in the definable flood plain. More essential than ever to the process of managing the flood plain becomes the righting of "rights" gone wrong. ■

EXPO74
Salute to the Environment

by James E. Paley
Public Affairs Office, Seattle District

Celebrating Tomorrow's Fresh New Environment

An eloquent testimonial to man's imagination and soaring hopes for the future, this is the theme of Spokane's Expo '74, billed as America's only major international event during the decade of the '70s.

Previous world's fairs and expositions in Chicago, New York, Seattle, San Francisco, Brussels, Montreal and Osaka heralded man's victory over the environment through developing technologies and industrial accomplishments.

But to the backers of this world's fair, "the inspiration of Expo '74 will be its exciting, entertaining and pragmatic proof that the essential vitality of progress must, and will, advance *in partnership with responsibility to the land, the air, the water . . . and to survival.*" These lofty thoughts were the basis for the lofty theme expressed above.

Spokane has been described in many ways, by many people—as an overgrown cow town, a wide spot on the road between Idaho's Coeur d'Alene and Canada's Calgary, and a young, dynamic city in the middle of nowhere. Despite these derisive comments, the fact is that Spokane is the center of a standard metropolitan statistical area (SMSA) of about 300,000 people. It has three full fledged colleges—Gonzaga, Whitworth and Fort Wright—two community colleges, and 10 miles out of town is Eastern Washington State College. Spokane has five hospitals within the city limits. One of them,

Left—This artist's conception of Expo '74 shows the finished buildings and grounds. The Corps did a flood hazard study for the site.

Sacred Heart Medical Center, opened a new 500-bed building in 1972 containing the latest developments of medical science available to treat the sick and injured, including a linear accelerator for radiation therapy—something few hospitals have in their inventory.

Spokane also has people with the vision and energy to push for this world's fair—Expo '74—which will run from May 4 through November 3, 1974. The exposition site is the Spokane River, which flows through the city center and is the outlet for Idaho's Coeur d'Alene Lake, far to the east. From Spokane the river continues westward into Franklin D. Roosevelt Lake above Grand Coulee Dam on the Columbia River.

Expo '74 will be centered on Crystal and Havermale Islands, both small river encircled pieces of the city's heart. The total fair site, 100 acres in all, includes not only these two islands but part of the land along both river banks as well.

The Corps became involved in the summer of 1972 for two reasons. First, the Seattle Engineer District was asked to complete a flood hazard evaluation of the fair site to satisfy the requirements of Executive Order 11296 before Federal support could be guaranteed.

Second, the Seattle District was requested by the Spokane County Board of Commissioners to assist it in formulating a Metropolitan Spokane Region Water Resources Study that would meet current Federal and State requirements for pollution abatement. The Corps accommodated this request in the spring of 1973 by expanding the scope of its own ongoing Spokane River and tributaries study by adding a major emphasis on urban problems. These include urban runoff and flood control, water supply, regional water quality, wastewater management alternatives and related water resource needs for metropolitan Spokane.

Although conducted by the Corps under contract to two engineering companies, the study is sponsored by the Spokane Regional Planning Conference. The Conference, in turn, is receiving close cooperation and guidance from the city and county, the State Department of Ecology, Spokane River Basin Coordinating Committee, Environmental Protection Agency and the general public in the Spokane region.

Plans will be developed by the study to meet regional water pollution control and abatement in three phases. Phase I will produce a gross analysis. Selected alternative plans will be refined during Phase II along with detailed project costs and evaluation of economic and social needs. A report will also be prepared for local use in meeting Federal and State requirements. Phase III will be a detailed report on the Spokane River Basin for submission to Congress.

These plans will attempt to meet current and near future needs through 1985 and the longer range needs of the next century.

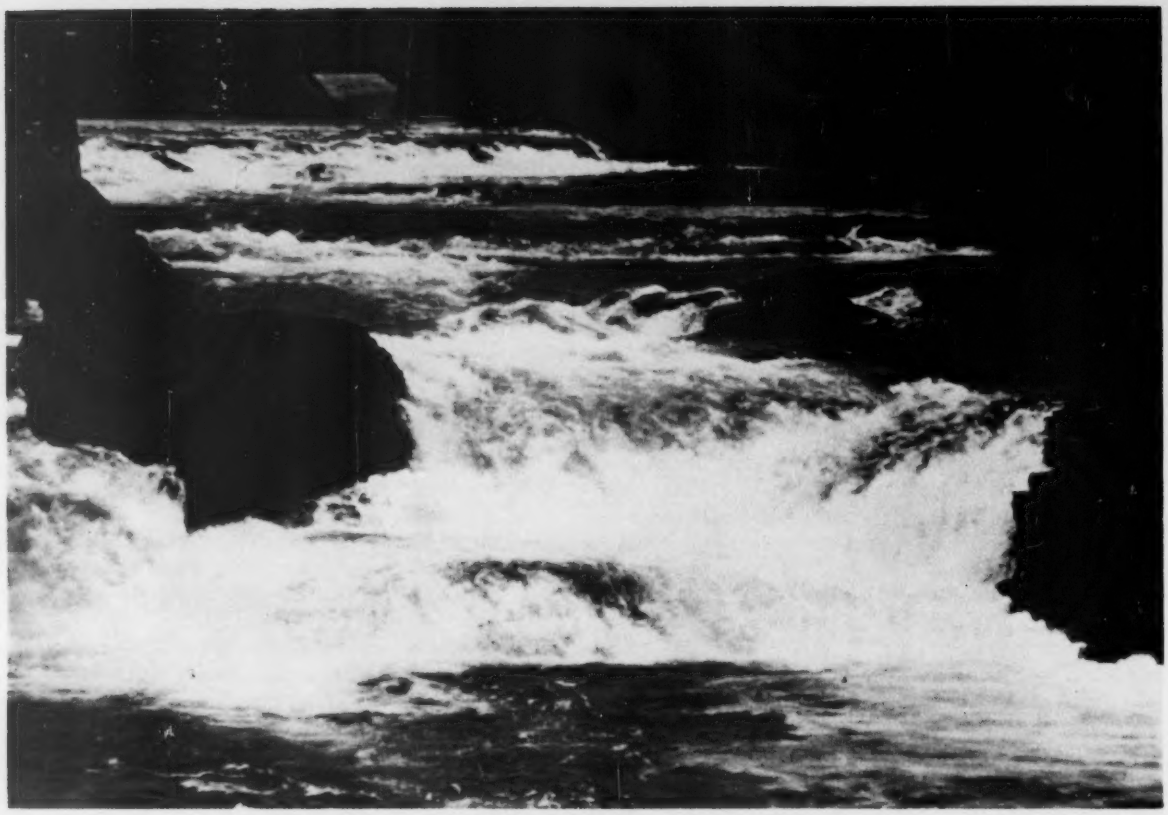
Much of the pollution for downstream Washington State comes from the mining activities practiced in the mountainous Idaho Panhandle, where the Spokane River originates.

Last fall the Panhandle Health District asked the Corps to extend its study into this part of Idaho. That request has been considered in the light of both Corps capabilities and effect on the present status of the Spokane study. Although a decision has not been made, the Corps is maintaining coordination with interested groups in Idaho.

In view of the study's relationship to the world's fair river site, Expo '74 backers claim that the coming of the fair has been the catalyst for upstream efforts to clean up the river. Three towns in northern Idaho which used to dump raw sewage into the Spokane have passed bond issues to finance construction of municipal sewage treatment plants. These communities are expected to have their plants in operation by opening day.

The chairman of the Expo '74 Corporation has gone as far as boasting that the local river water will be of such quality by the time the fair opens that the water will actually be safe enough to drink.

The area outlined covers about 100 acres of the Spokane River's islands and banks. Old buildings on the site were removed to make room for Expo '74 facilities as depicted in the artist's concept on the preceding page.



The Spokane River flows between the tips of Crystal and Havermale Islands, main site of Expo '74.

Expo '74 has been sanctioned by the Bureau of International Expositions (BIE) as a special-category fair: a thematic exposition on the environment. Operating under the rules of the 36-nation BIE entitles the host nation to employ a U. S. commissioner of ambassadorial rank while negotiating with other countries. President Nixon appointed J. Welles Henderson, a lawyer from Philadelphia to personally contact foreign representatives.

During his first European trip to follow-up on the President's invitations to other BIE member nations, Ambassador Henderson immediately ran head-on into one of Expo's major problems in soliciting their participation.

"Spokane?"—"Who's he?" ... "What's that?" ... and "Where's that?"

Ambassador Henderson persisted, however, with the result that there are many foreign country attractions planned for Expo '74. The USSR, Australia, Canada, Iran, France, Mexico, Japan, the Republic of China, the Republic of Korea and Belgium have all signed contracts guaranteeing their participation; in fact, the USSR was interested enough to reserve an unprecedented 52,000 square feet for its pavilion.

A permanent structure of unusual design houses the U. S. pavilion on Havermale Island. Two semi-circular buildings are physically united via a circular vinyl canopy supported by a 145-foot tall center pole. Inside, a national exhibit entitled "Man and Nature, One and Indivisible" will relate American culture and technology to our environment.

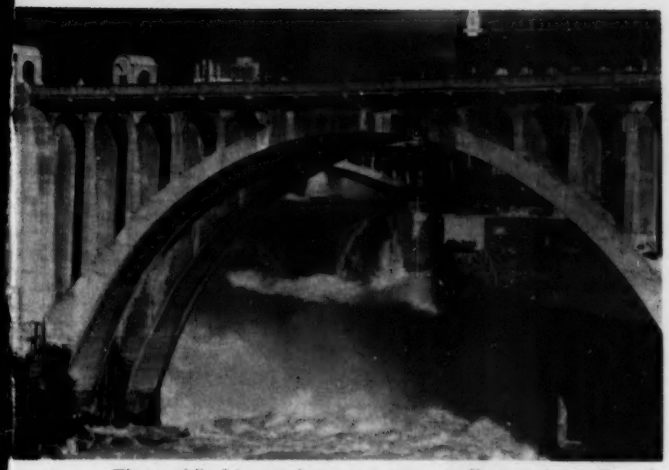
Three-dimensional displays will feature the subthemes of *energy, noise abatement, solid waste, air pollution* and *transportation.* The largest screen in the world will stun the viewer with detailed shots of natural phenomena presented on 180-millimeter film.

A garden exhibit will highlight natural phenomena such as trees, flowers and cascading water. This exhibit will also serve as a rest area as well as an arena for music and other activities.

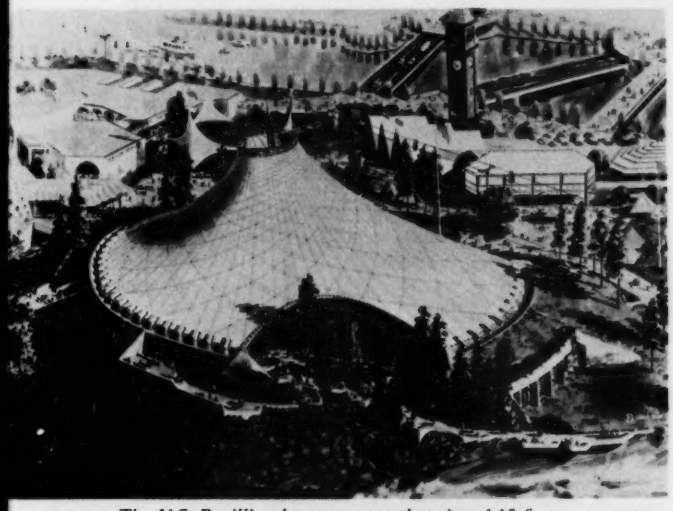
The Environmental Communications Center of the national exhibit will become a permanent facility—both for the casual visitor and for the scholar seeking instant access to information related to all aspects of environmental management and planning.

In its overall impact this pavilion will strive to honor the colorful history of America as it was forged on the plains, the mountains, the waterways and the seashores. The combined thrust of these presentations will emphasize how the natural bounty of the land helped build this country; and now it is our turn to protect the land.

The scope of the proposed exhibits in the U. S. pavilion has already justified designation of the fair as an official celebration event by the American Revolution Bicentennial Commission. Therefore, this exhibit will be continued through the official Bicentennial Era, which will begin in 1976. Besides both buildings containing the U. S. exhibit, a third permanent building will be the huge wedge-shaped structure housing the *Washington State*



The world's fair may have a permanent effect on the quality of water that flows over Spokane Falls at the lower end of the fair site. Backers claim the fair is stimulating extensive cleanup efforts, including construction of treatment plants by upstream towns that formerly dumped raw sewage into the river.



The U.S. Pavillion has a canopy that rises 145 feet on a center pole. Among the Pavillion's featured exhibits will be water uses and environmental values related to water.

Pavilion for State Exhibits and the Performing Arts ... billed as an imaginative spectacular.

The State exhibit will be historical and artistic in concept ... with a background of Indian legends, bountiful water power and related resources, rich farmland and scenic mountains. Part of this exhibit will feature dams built by the Corps, public utility districts and the Bureau of Reclamation in the Columbia River Basin. They will be identified as sources of development that helped change the arid wastes of central Washington into rich and productive land supporting today's bountiful fruit orchards and lush fields of crops.

From one of three steep-walled tiers the visitor may view a panoramic scene drawing one into a visual experience of being present at the dawn of history as man's relationship with the environment through the ages unfolds on a gigantic screen.

In the Opera House adjoining the Washington State pavilion will be a 2,700-seat theater where operas, top-ranked popular artists, philharmonic orchestras and foreign stage presentations will entertain visitors. The schedule of planned events includes practically every big name in the "Who's Who" of the entertainment world. The list will include Brazilian folk troupes, the Seattle opera, Lawrence Welk, the Moiseyev Dancers, violinist Isaac Stern, pianist Van Cliburn, the Mormon Tabernacle Choir and the King Sisters.

The visual arts portion of the pavilion consists of 30,000 square feet of space filled with environmental art embodying the theme "Our Earth, Our Sea, Our Sky." The latter will in turn divide into more definitive displays depicting specific sub-themes: "Man and the Wilderness," "Tonalism and Impressionism," "When the West Was Wild," "Naturalism and Realism," "The Big City," "Nature in Abstraction," and "Earthworks." Each of these sub-themes is to be illustrated through masterpieces painted, sculpted and constructed by world-renowned artists.

Participation of the Smithsonian Institute marks the first time this famed institution has joined in an exposition of this nature. The Smithsonian will present "Life and Traditions of the Northwest" as the feature of its own six-month Folklore Program Series.

Still other exhibits and pavilions will highlight the respective cultures of the Northwest Indian tribes and the Eskimos. There will be gourmet restaurants, reproductions of exotic bazaars and a turn-of-the-century frontier town, a variety of games and rides, as well as industrial displays by some of the country's largest manufacturers. There will also be theme pavilions on energy, agriculture and life styles, all related to the overall environmental theme of the fair.

In keeping with this theme, a planned series of symposia will be incorporated into the fair for the purpose of discussing the world's environmental problems. Scientists, policy makers and the general public will participate in these discussions, scheduled both before and during the actual fair.

International experts will be invited to hold three general meetings among themselves. In addition, separate meetings will call upon experts from the various nations represented at the fair to discuss problems within their own countries. Yet other meetings will involve the public in a manner that will allow the latter to tell the experts what the public thinks about major environmental problems.

Mel Alter, director of the Expo '74 environmental program, explained the aim of these meetings will be to invite the public, the policy makers and the experts to discuss ways to make the earth a better place to live.

As Alter pointed out, "the problems we discuss will be typical of those in the rest of the world. We're using the Pacific Northwest as a microcosm of the world. Improving the environment is what Expo '74 is all about," he added, "and it is vitally important to all of mankind."

The Washington State Pavillion, foreground, will house an exhibit which will continue through the Bicentennial Era beginning in 1976. Part of the exhibit will feature the role of Columbia River Basin dams in the development of the Northwest.

Construction for Expo '74 has already netted the city of Spokane enormous dividends. A few short years ago, the riverfront and the two islands in the river were a mass of jumbled railroad tracks, dilapidated warehouses, two old railroad stations and a waterfront with all the earmarks of a skid row.

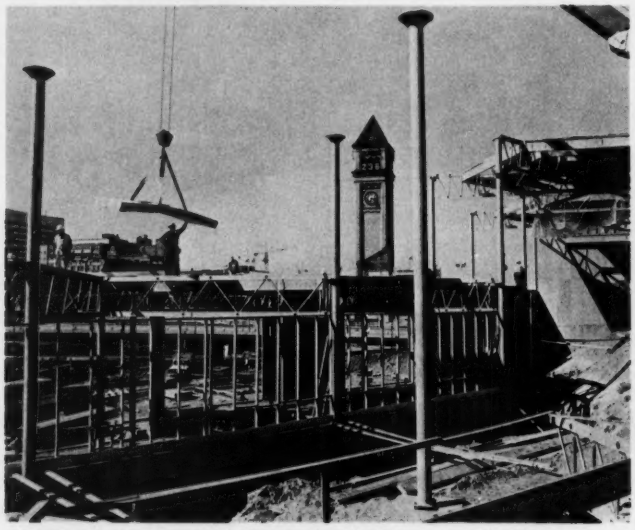
With the transfer of land and buildings from the Burlington-Northern and Union Pacific Railroads to the city, the rails were torn up, the railroad bridge across the Falls of Spokane removed, the warehouses and stations razed. All except the stately clock tower from the old Great Northern station. This impressive memento of the old riverfront was saved for posterity and has been transformed into a key element in preparing for the coming of the fair.

Spokane's city engineer appropriated the notable structure for use as a countdown tower, highly visible from all directions. Starting with initial preparations back in 1972, the number of days remaining appears above the clock on all four sides and will continue to be changed daily right up to opening day.

Since 1972 the old city center area has been redeveloped around the clock tower as part of the planned exposition. As a result Spokane will hold title to a beautiful 100-acre riverfront park containing three permanent buildings when Expo '74 folds its wings in October 1974. Washington State's pavilion will be retained as a convention center, and both buildings housing the U. S. pavilion will become part of the future Bicentennial Era exhibition.

The momentum of Expo '74 has carried over into the adjoining business community. Beautiful new buildings have been erected close to the waterfront ... department stores have modernized and expanded ... and an aura of confidence pervades the downtown business area of the city.

Expo '74 has not been without its share of difficulties,



The Russian Pavillion 236 days before the Fair's opening date. The clock tower displays the countdown for number of days left for preparation of all facilities.

however. Many were concerned that despite the fair's contribution to national and international progress in environmental matters, the fair could add to Spokane's air pollution and overload the sewage system. The total cost is about $76 million, requiring a business and occupation tax, and it involved a complicated land transaction. On the other hand, the fair's officials point to a range of environmental and economic benefits that will accrue to the area and seem confident that major problems are under control.

Regardless of the difficulties, the promise of Expo '74 is an assault upon all the senses with spectacular rides, thrills, color, music, discovery, art, demonstrations, shows, exhibits and the challenge to everyone to help in *Celebrating Tomorrow's Fresh New Environment!* ■

Events, Deeds & Deliberations

8 Co-Sponsors Organize National Flood Plain Conference

A National Conference on Flood Plain Management will be held in Washington, D.C., at the Statler-Hilton Hotel from July 23 through the 25th, 1974.

This National Conference is co-sponsored by eight organizations: the American Forestry Association; American Society of Planning Officials; Council of State Governments; Keep America Beautiful; National Association of Conservation Districts; Soil Conservation Society of America; Sport Fishing Institute; and the Wildlife Management Institute.

The conference program will cover four major areas: Uses of Flood Plains; Experiences in Flood Plain Management; Avenues to Improved Flood Plain Management; and Recommended Initiatives.

Consultants for program planning and participation represent the Bureau of Outdoor Recreation, Fish and Wildlife Service, Geological Survey, from the Department of Interior; Forest Service and Soil Conservation Service, Department of Agriculture; Corps of Engineers, Department of the Army; Department of Housing and Urban Development; Environmental Protection Agency; and the Water Resources Council.

Additional information may be obtained from the Conference Chairman, Mr. Gordon K. Zimmerman, Executive Secretary, National Association of Conservation Districts, 1025 Vermont Ave., N.W., Washington, D.C. 20005. ■

Water Resources Development Act of 1974

Several new trends of national interest appear in the Water Resources Development Act of 1974, designated Public Law 93-251. Approved 7 March 1974, the act requires the Secretary of the Army, acting through the Chief of Engineers, to perform several new functions.

Section 1 is a major innovation in that it establishes a two-stage authorization procedure for projects costing over $10 million. The first stage limits authorization to a general design memorandum in which the project's formulation and evaluation are reviewed. This review is based on prevailing conditions and any changes that may have occurred since the pre-authorization survey study. This is Phase I of the project.

Continuation into Phase II depends on favorable recommendations by the Chief of Engineers prior to review and approval by the President and the Congress. Approval to continue into Phase II authorizes advanced engineering and design. Also, construction appropriations cannot be made until a project becomes eligible for Phase II. Projects costing under $10 million will continue to be authorized under Section 201 of the Flood Control Act of 1965 (Public Law 89-298).

Of equal interest is the new deauthorization procedure established in Section 12. This section requires annual submission of a list of projects proposed for deauthorization from the backlog of projects which have authorizations at least 8 years old, and which also have not received any congressional appropriations during the preceding 8 years.

Any project recommended for deauthorization will receive an automatic 180-day waiting period, during which a resolution to continue specific Corps authorizations may be adopted by either Public Works Committee. The intent is to remove projects from the authorized backlog list which are no longer needed, wanted or justified after consultation with other Federal agencies and the concerned States.

Section 22 establishes a new program of cooperative

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statewide comprehensive planning for water resources development, utilization and conservation between the Corps of Engineers and individual States.

Section 32 authorizes the Corps to establish a $25-million, 5-year national program to evaluate and demonstrate streambank erosion control projects.

Section 54 authorizes the Corps to establish an $8-million, 5-year national program to develop and demonstrate low-cost means for control of shoreline erosion.

Section 73 endorses Federal participation with local interests in promoting non-structural flood control measures and calls for cost sharing comparable to that required for structural protection.

Section 80 provides for use of the interest rate formula published by the Water Resources Council in the Federal Register of 24 December 1968 and the "grandfather clause" for applicable projects. This section also directs the President to investigate principles and standards for water resource projects, including as objectives the consideration of regional economic development, environmental quality, public well-being and national economic development. This study will result in a report including discount rates and cost sharing, accompanied by recommendations to the Congress for future action.

Section 108 authorizes the Big South Fork National Recreation Area in Kentucky and Tennessee. After development of access and other public facilities by the Corps of Engineers, the area will be turned over to the Secretary of the Interior for operation. ■

Shades of Rube Goldberg!

Ingenious and sometimes surprising ways to save electricity have been publicized as firms and individuals throughout the Nation make efforts to reduce their energy consumption.

One of the more unique examples is at the Portland District's Lost Creek Lake, a flood control project under construction in Oregon, where the main dam contractor has modified a familiar construction operation to come up with an innovative energy-saving idea.

Tons of rock and earth moving down a 3,000-foot conveyor belt are being utilized to produce electricity—enough to supply the electrical needs at the construction site plus some extra that the contractor is selling to the local power company.

At the same time, by using the long conveyor belt to bring material down the mountainside to the dam site, the contractor estimates that 1,375,000 gallons of diesel fuel will be saved in two years, since the conveyor belt eliminates the need for long truck hauls.

Here's how the conveyor belt generates electricity: Two 300-horsepower electric induction motors are used to start the conveyor system moving. Once the belt is moving with a full load, the weight of the material runs the belt by gravity. As the belt speeds up faster than the synchronized speed of the motors, they convert to generators and feed electricity back into the powerline, rather than draw electricity from it.

When work is in full swing and the conveyor is fully loaded with one ton of rock every 17 feet, the conveyor belt will generate an estimated 550 kilowatts of electricity. That computes to about five million kilowatt-hours of generation over the two years the conveyor will be in operation.

When Lost Creek Dam is completed in spring 1976, its new powerhouse will generate 49,000 kilowatts of electricity. But then the electricity will come from water power, not rock power. ■

Very Hard Water

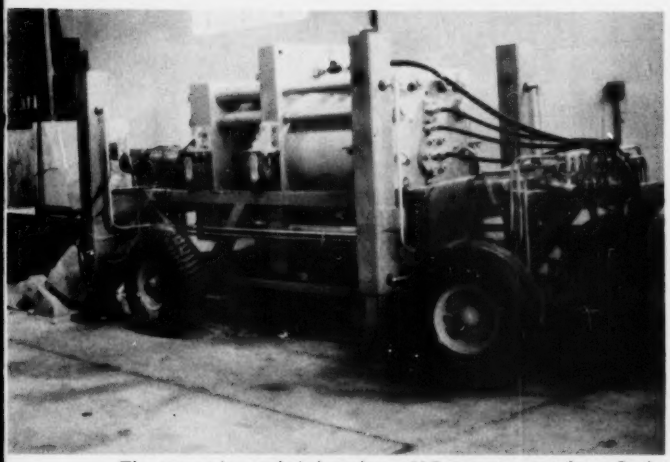
A cannon which shoots a one-quart jet of water at the velocity of 9,800 feet per second is being developed for the Department of Transportation's Federal Railway Administration. The experimental model was designed under contract by Terraspace, Inc., of Rockville, Md., for possible use in tunneling work. When aimed at a cube

This 3,000-foot conveyor belt, modified to generate its own electricity, moves tons of rock and earth from a construction site to dump trucks.

of sandstone, limestone or granite, the rock breaks; and furthermore, the bit doesn't wear out. At this stage, however, it's a one-shot operation. The challenge is to give it a machine gun capacity for field work.

Pressure of the jet reaches 650,000 pounds per square inch (psi) and the jet of water breaks rock in much the same manner as a pick breaks ice.

According to the designer, Dr. John Cooley, the efficiency at pressures in the region of 500,000 psi is comparable to the best current tunneling methods. The way he generates that much energy is by powering the cannon with an oil hydraulic system that compresses nitrogen gas. Upon firing, the gas accelerates a 143-pound, seven-inch diameter piston up to a speed of 140 miles an hour in a distance of one foot. The energy is transferred to the water which is effective out to a range of several inches from the end of the nozzle. The slug of water coming out of the nozzle has a jet pressure nearly four times higher than the pressure against the nozzle walls. ■



The cannon's nozzle is based on a U.S. patent granted to a Soviet scientist, Prof. B.V. Voitsekhovsky. When the cannon is fired a slug of water is forced through the nozzle by the impact of a high velocity piston.

A stream of water about 1/3 inch in diameter hits a cube of rock at the velocity of nearly two miles per second, and the volume of rock broken per shot exceeds the amount of water used.

Administration Endorses Deep Port Construction

President Nixon's energy message to the Congress indicates that the national goal of self-sufficiency in energy will not preclude construction of deep port facilities.

He said, "Even though our policy is to achieve self-sufficiency, we will clearly continue to import oil as long as it is available at reasonable prices.

"To enable us to import fuel more economically, I have proposed Federal Government licensing of the construction and operation of deepwater port facilities three miles or more at sea on the Outer Continental Shelf.

"The main use of these facilities would be to import crude oil in ships that are economically and environmentally desirable, but are too deep of draft to permit their entry into our port facilities on the East and Gulf Coasts."

Several different versions of deep port authorizing legislation are under consideration by the House of Representatives and the Senate. ■

Omen Noises?

Earth dams will sound off under conditions of stress, if only one is equipped to properly hear them, according to two Drexel University researchers who have constructed a device that listens.

Dr. Robert M. Koerner, associate professor of civil engineering, and Dr. Arthur E. Lord, associate professor of physics, jointly built a prototype noise sensor that converts the sounds of minute stress waves into electrical impulses that can be measured. The sensor is based on the premise that solids under pressure emit sub-audible sound, commonly designated stress waves or acoustic emissions.

Relatively little work was done in measuring these emissions until Dr. Koerner read a story about a Canadian town plagued by the continual howling and baying of its dogs a week before subsurface earth movements caused its collapse. If these animals heard sounds their owners did not, they reasoned, perhaps a connection existed between soil movement and noise.

Drexel's researchers tested their theory and their results confirmed that common types of soil make considerable noise under stress. ■

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